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JUL 8 1924

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Steam & Crude Oil Road Rollers, &c.
1869

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ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement page 10.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
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See half-page Advert. last week and next week. 2087

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STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited,
BIRMINGHAM. 1241
See Advertisement last week, page 19.

Spencer-Hopwood & Kirke
PATENT BOILERS *See Page* 75. 1994
Sole Makers: SPENCER-BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 1864

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RAILWAY CARRIAGES AND WAGONS
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RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
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Hammers, Presses, Furnaces,
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SPECIALISTS
in the
SALE AND VALUATION
of 1834
PLANT AND MACHINERY
and
ENGINEERING WORKS.
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Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 817
The Scottish Tube Co., Ltd.
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement, page 55.

YARROW & CO. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS.
1553

Campbells & Hunter, Ltd.
Gear Cutting.
Worm Wheels cut up to 18 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
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DOLPHIN FOUNDRY, LEEDS. 4547

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PORTSMOUTH,
SHIP & LAUNCH BUILDERS, Od 3551
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THE GLASGOW ROLLING STOCK AND PLANT WORKS.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON & BRASS CASTINGS.
PRESSED STEEL WORK OF ALL KINDS. Od3382
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Systems
PRESSURE, AIR, STEAM
For Boilers of all types.
KERMODES LIMITED,
35, The Temple, Dale Street, Liverpool.
Naval Outfits a Speciality,
also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
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Locomotives Tank Engines
designed and constructed by
MANNING, WARDLE AND COMPANY, LIMITED.
Boyne Engine Works, Leeds. Od 2487
See their Illus. Advertisement, page 89, last week.

Gearing of all Descriptions.
GEAR WHEELS up to 10 ft. diameter.
FLY ROPE and SPUR DRIVING WHEELS up to 28 ft. diameter.
BRICK and CLAYWORKING MACHINERY of all kinds.
ENGINES:—"Uniflow," "Corliss," or Drop Valve.
CLAYTON, GOODFELLOW & CO., LTD., Blackburn. 1349

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(Established 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS
MAKERS of WHEEL and AXLES of all kinds
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices:
WISHAW, near GLASGOW.
London Office: Od 8353
3, VICTORIA STREET, WESTMINSTER, S.W.

Patents.—Exhibition Visitors
can obtain information respecting patents, etc., from B. T. KING, Regd. Patent Agent, 146A, Queen Victoria St., E.C.4. For free appointment Wembley Exhibition, 'Phone Central 682. Handbook free.

For Your Repairs or any
SPECIAL MACHINERY, try
THOMAS HUNT & SONS,
Albion Ironworks,
Bridge Road West, Batterseа, S.W. 11.
Est. 1854. 2213

E. J. Davis, M.I.Mech.E.,
Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising, London."—Great Eastern Road, Stratford, E.15. 1794

Rosser and Russell, Ltd.,
MECHANICAL ENGINEERS,
QUEEN'S WHARF, HAMMERSMITH, W.
Undertake SPECIAL MACHINE WORK of any description.
WELL EQUIPPED SHOP.
LATHE WORK up to 10 ft. diameter.
'Phone: Hammersmith 31, 967. 2211

John Bellamy, Limited,
MILLWALL, LONDON, E. 1216
GENERAL CONSTRUCTIONAL ENGINEERS,
Boilers, Tanks, & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETED STEAM AND VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

IRON & STEEL
Tubes AND Fittings AND Steel Plates.
STEWARTS AND LLOYDS, Ltd.
GLASGOW BIRMINGHAM - LONDON.
See Advertisement, page 96. 1872

Peter Brotherhood Ltd.,
PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 51, June 20.

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 101, LEADENHALL ST., E.C.3.
Works: BURNT MILL, near HARLOW, ESSEX.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers,
&c., &c. 1586

Important.—For Immediate
SALE AT LOW PRICES.
One Superior 400 Kw. Howden - Siemens ELECTRIC GENERATING SET, 250 volts D.C., 350 r.p.m., 155 lbs. pressure.
One High-Class Horizontal Side - by - Side COMPOUND CORLISS ENGINE, 200 I.H.P. at 80 r.p.m., belt flywheel 12 ft. diameter by 2 ft. 6½ in. on face, very suitable for export, for driving factory, sawmill, etc.
One Powerful Set COMPOUND HORIZONTAL HYDRAULIC PUMPING ENGINES, by Sir Wm. Arrol & Co., capacity 200 gallons per minute.
Two Steamdriven CENTRIFUGAL PUMPS, by Drysdale, capacity 1250 and 1390 gallons per minute.
In new condition and all seen here at Glasgow.
JOHN H. RIDDELL LTD.,
40, St. Enoch Square, Glasgow. 2191

MACHINE CUT
Gears.
Spurs, Bevels,
Spiral, Worm and
Worm Wheels.
HIGHFIELD GEAR CUTTING CO.
(Dept. E.),
Huddersfield. 1645

HEAT INSULATION.
CELITE PRODUCTS CORPORATION,
Windsor House, Westminster, S.W.1. 1675
See our Illustrated Advertisement, June 6.

"Delta" Brand HIGH-CLASS ENGINEERING ALLOYS.
Forgings, Castings, Bars, Sheets, Wire, Tubes.
THE DELTA METAL CO., LTD., 2033
E. GREENWICH, LONDON, S.E.10 (& at Birmingham)

Telegrams: "Epa," London.
Telephone: 7494 Central.
E. P. Alexander & Son.
CHARTERED PATENT AGENTS,
306, High Holborn, London, W.C. 1. 585
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Semi - Automatic
METALLOGRAPHY
—at the rate of over 100 per hour at × 100.
F. DAVIDSON & CO.,
20, Great Portland St., London, W.1. 2114

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS,
CALORIFIERS EVAPORATORS, } ROW'S PATENTS,
CONDENSERS, AIR HEATERS,
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES.
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

YARROW & CO. (1922), LTD., GLASGOW.
LAND AND MARINE
YARROW BOILERS.
1553

Matthew Paul & Co., Ltd.,
Dumbarton. 2213
LEVENFORD WORKS.
See Full Page Advt., page 56, June 20.

Forgings.
Walter Somers, Limited,
HALESOWEN. 7116

Taylor & Challen Presses
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works and Showrooms: BIRMINGHAM.
See Advert., page 96, June 20. 3196

The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. LTD.,
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also
CAST-STEEL AXLE BOXES. 1948

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED,
DARLINGTON. 2006

RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.,
THE GLASGOW ROLLING STOCK AND PLANT WORKS,
MOTHERWELL. Od 3382

Govan Engine Works,
LIMITED.
The whole of the
MACHINERY, TOOLS, PLANT, Etc.,
of
GOVAN ENGINE WORKS
(lately belonging to
Messrs. DUNSMUIR & JACKSON, Limited,)
FOR SALE
by Private Bargain.
For particulars apply
180, Hope Street,
Glasgow.
D 431

Centrifugals.
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND.
1676
See half-page Advertisement, page 51, June 6.

The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by Sir WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 2005

ROYAL AIRCRAFT ESTABLISHMENT.

An Examination for the entry of ten Trade Lads to the above Establishment will be held on TUESDAY, 29th JULY, 1924.
Application for admission to the examination must be made on the prescribed form, which must be filled in and returned not later than Tuesday, 22nd July.
Application forms and the regulations governing the conditions of entry and training of Trade Lads may be obtained by post from :—
THE SUPERINTENDENT,
Royal Aircraft Establishment,
South Farnborough, Hants.,
or by personal application at the R.A.F. Employment Department. F 161

Correspondence Courses for

Inst.Civil Engrs., Inst.Mech.E., London Univ. (Matric., inter., B.Sc.), and All ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M.Inst.C.E., M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 56, SOUTH JOHN STREET, LIVERPOOL. 1993

Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 2108

T. G. Howes Thomas, (Inst.

C.E. Coach, late of Westminster), Consulting Engineer, has resumed his "Up-to-date" Coaching by correspondence, and is prepared to advise on proposed or accepted patents.
34, Baldwin Street, Bristol. D 847

TENDERS.

For Sale.—Two 50 Cwt.

Hydraulic Portal Pier COAL UNLOADING CRANES (reconditioned), 38 ft. radius, Luffing Jibs, slewing and (hoisting motions, mounted on pedestal base with 4 wheels running on track, 11 ft. 6 ins. centres, spanning wagon road 4 ft. 8½ ins. gauge. These may be inspected by appointment on application to THE CHIEF OFFICER OF STORES, Gas Light and Coke Company, Horseferry Road, Westminster, S.W.1, to whom all Tenders should be addressed. F 149

For Sale by Tender as a GOING CONCERN the OLD ESTABLISHED ENGINEERING BUSINESS

carried on by
COWLISHAW, WALKER & COMPANY (1920), LIMITED,
at RAILWAY ENGINEERING WORKS, ETRURIA, STOKE-on-TRENT.

Comprising extensive Copyhold Works, covering 1¼ acres with ¼ acres of land adjoining, giving ample room for development, together with Private Siding to main line of Railway.
The BUILDINGS are laid out on up-to-date lines and consist of spacious Iron and Brass Foundry, Machine Shops and Erecting Shops, all equipped with overhead Electric Travelling Cranes, and are equipped with machine tools of the most modern description.
The Stores and Office accommodation is spacious and conveniently arranged.
The whole of the MOTIVE POWER is Electric, on the three-phase system, current being obtained from the Stoke-on-Trent Corporation Supply.
The Works are heated throughout on the "Plenum" system, and a compressed air power supply is generated on the premises.
The valuable English and Foreign Patent Rights and the Goodwill, Patterns, Designs, Drawings, Loose Plant, Stock-in-Trade and Effects will be included in the sale.
The book debts can be taken over or not, as desired.
The principal business of the Company is the manufacture of COALCUTTING MACHINES of both bar and chain type, and new designs and Patents recently taken out, both at home and abroad, place them in an excellent position for supplying any type of Coalcutting Machine required for English and Foreign Coalfields. In all, the manufactures cover a range of 33 different machines which meet all the different requirements of Machine Mining under any conditions.
The Company are also the sole makers of the well-known Brush Clutch for power transmission and are well-equipped for general engineering work and the supply of iron castings up to 15 tons in weight.
The business is being actively carried on, and there is a good demand for the Company's manufactures both at Home and Abroad.
The Company's interest in the Engineering firm of Robert Warner & Company (Engineers), Limited, the well-known Manufacturers of Treble Ram and Boiler Feed Pumps, will be included in the sale.
Tenders may be made for separate Lots if desired, but offers for the whole business will receive priority of consideration.
Full Particulars, with Schedules of Plant and Machinery, etc., and Conditions and Forms of Tender may be obtained at the premises, or from the undersigned, or from :—
PADDOCK, SON & ORME,
Solicitors,
HANLEY.
Tenders must be delivered to the Receiver at his Office, on or before Twelve o'clock Noon, on Monday, the 7th day of July, 1924.
The highest or any Tender will not necessarily be accepted.
DATED this 25th day of June, 1924.
F. W. CARDER,
Chartered Accountant,
Victoria Chambers,
STOKE-ON-TRENT,
Receiver for Debenture Holders. F 140

ELECTRIC LIFTS.

For the New Legislative Buildings, Delhi. Six Passenger Lifts, One Goods Lift and Two Sets of Two Service Lifts.
For the Government House, Delhi. Five Passenger Lifts, Three Goods Lifts and Seven Service Lifts.

Tenders are Invited for

the MANUFACTURE, DELIVERY in India, ERECTION and TESTING on site, with endurance test of one week, of the above LIFTS.
Tenders will be considered in India on 24-8-24.
Firms not already submitting Tenders through their Indian Agents may inspect copies of the Forms of Tender and drawings at the India Store Depot, London, by application to :
THE DIRECTOR-GENERAL OF STORES,
Branch No. 16,
Belvedere Road,
Lambeth, S.E.1. F 124

CORPORATION OF THE CITY OF AUCKLAND, NEW ZEALAND.

QUARRY PLANT.

MOTORS, CRUSHERS, etc.

The above Corporation invite

Tenders for the Supply

of PORTION or the whole of the following PLANT :—
(1) A Large Jaw Crusher, capable of dealing with 1½ cwts. spawls (columnar basalt) and reducing same to 3 inches and less, at the rate of 250 cubic yards per day of eight hours.
(2) Two Jaw Crushers, each capable of reducing 125 cubic yards of 5 inch spawls to 2½ inch and less, per day of 8 hours.
(3) One or two Disc Crushers, capable of dealing with 120 cubic yards of 2 to 4 inch spawls, and reducing same to ¾ inch and less, per day of eight hours.
(4) One belt-driven Air Compressor, capable of supplying 200 cubic feet of free air (working pressure 100 lbs. per square inch).
(5) Five three-phase Electric Motors, 400 volts, 50 cycles, on adjustable rail beds to drive the above.

Specifications and full particulars may be seen at Room 40, New Zealand Government Office, 415, Strand, W.C. 2, on and after Monday, June 23rd, and, for the purpose of supplying information, the Assistant City Engineer of Auckland may be consulted at the above Office between the hours of Eleven a.m. and One p.m., on Monday, June 30th, Tuesday and Wednesday, July 1st and 2nd.
Sealed Tenders, endorsed "Tenders for Crusher Plant," to be addressed to :—
Mr. JAMES TYLER,
c/o New Zealand Government Office,
415, Strand, London, W.C.2,
not later than Twelve Noon, Thursday, July 10th, 1924.
The Corporation reserves the right to accept a Tender for the whole or portion of the plant quoted for, and it does not bind itself to accept the lowest or any Tender.
(Sgd.) J. TYLER,
Assistant City Engineer.
Office of the High Commissioner for New Zealand,
415, Strand,
London, W.C. 2.
June 14th, 1924. F 59

IN THE HIGH COURT OF JUSTICE (Companies Winding Up).

To be Offered For Sale by

TENDER, pursuant to a Order of the Registrar Companies (Winding Up) made in the matter of ALLEN & SIMMONDS (READING), LTD., Branch Nominees Ltd., v. Allen & Simmonds (Reading), Ltd., 1923, A. No. 2686, either in One Lot as a Going Concern, or in the following Lots :—
LOT 1.
(A) A FREEHOLD GARAGE, SHOWROOMS AND OFFICES situate in the centre of READING, with frontages to Friar Street and Station Road, and containing an area of about 23,000 square feet, together with the Assets and the Business carried on on such premises, and the whole of the Share Capital and Debentures in Great Western Motors Ltd
(B) A block of TEN FREEHOLD COTTAGES adjoining the above.
(C) A FREEHOLD FACTORY at Vastern Road, READING, with Modern Buildings thereon, covering an area of about 14,500 square feet, at present let as a Motor Body Building Works, in connection with the aforesaid business.
LOT 2.
(A) A LEASEHOLD ENGINEERING WORKS, at READING containing a total floor space of about, 27,000 square feet, held for an unexpired term of 67 years at Ground Rents amounting to £77 6s per annum. These Works are equipped with high-class ENGINEERS' MACHINE TOOLS for the manufacture of Piston Rings and other Specialities of the Company.
(B) THIRTY LEASEHOLD COTTAGES and a RESIDENCE adjoining held for a similar period at nominal ground rents.
(C) LEASEHOLD PREMISES suitable for GARAGES, situate No. 107, Caversham Road, READING, held for an unexpired term of 61 years.
(D) A FREEHOLD PROPERTY on the THAMES, at CAVERSHAM, adjoining the Bridge, formerly a Club, but now let off in self-contained Flats.
(E) A FREEHOLD HOUSE, No. 18, King's Meadow Road, READING.
(F) THE GOODWILL OF THE BUSINESS of ALLEN & SIMMONDS (READING), LTD., as a Going Concern, and LETTERS PATENT for Improvements in the manufacture of Piston Rings, etc.
LOT 3.
3,000 £1 fully-paid Shares, Great Western Hotel (Reading), Ltd.
25 £1 fully-paid Deferred Ordinary Shares, and
5,500 £1 fully-paid Participating Preferred Ordinary Shares in the Reading Foundry Co., Ltd.
Tenders, which must be on the form contained in the Particulars, are to be sent to the Registrar, Companies (Winding Up), Room 48, Bankruptcy Buildings, Carey Street, W.C.1, and marked "Tenders Allen & Simmonds (Reading), Ltd.," and delivered under seal by TWELVE NOON, on or before SATURDAY, 19th July, 1924. Particulars, with Plan, Form of Tender and Conditions of Sale, may be had of Messrs. W. B. PEAT & CO., Chartered Accountants, 11, Ironmonger Lane, London, E.C.2, Messrs. WILDE, WIGSTON & SAPTE, Solicitors, 21, College Hill, London, E.C.4; and of Messrs. PEACOCK & GODDARD, of 3, South Square, Gray's Inn, London, W.C.1 F 32

The Director-General,

India Store Department, Branch No. 16, Belvedere Road, Lambeth, S.E. 1, REQUIRES :—
STEEL BOILER TUBES.
Tenders due on the 4th July, 1924.
Tender forms obtainable from above. F 164

LODGE HILL, near CHATHAM.

Tenders are Invited for

the PURCHASE and REMOVAL of the undermentioned TIMBER FRAMED HUTS, now at Chattenden Farm, Lodge Hill, and of approximate floor measurements as follows :
2 No. 60 ft. by 20 ft.
1 No. 60 ft. by 29 ft.
Tenders are to be delivered not later than Noon on July 11th, 1924, to SUPERINTENDING CIVIL ENGINEER, H.M. Dockyard, Chatham, from whom full Particulars and Forms of Tender may be obtained. F 128

WESTERN AUSTRALIAN GOVERNMENT.

ELECTRICITY SUPPLY.

POWER STATION PLANT.

The Government of Western Australia is prepared to receive

Tenders for the Supply

and DELIVERY, C.I.F. Freemantle, including erection, of the following :—
One 12,500 Kw. TURBO-ALTERNATOR, complete with Surface Condensing Plant.
WATER TUBE BOILERS, ECONOMISER, FANS, CHIMNEY, etc., also COAL and ASH PLANT.
The Government does not bind itself to accept the lowest or any Tender.
Sealed Tenders to be endorsed "Tender for Power Station Plant," and to be lodged with the AGENT GENERAL FOR WESTERN AUSTRALIA, Savoy House, Strand, London, W.C.2, not later than Noon on Friday, August 15th, 1924.
Copies of Forms of Tender and Specifications will be available on and after the 23rd June, 1924, on application to the Agent General for Western Australia as above.
A charge of £2 will be made for the first two copies of each Specification, additional copies being obtainable at 10s. each. These charges will not be returnable in any circumstances whatever.
Any further information can be obtained by applying to the General Manager and Engineer of the Western Austral an Government Electricity Supply, Mr. WILLIAM H. TAYLOR, at the above address on and after the 23rd June, 1924. F 61

ABERDEEN CORPORATION WATER WORKS.

EXTENSIONS 1920.

CONTRACT No. 20.
AIRY HALL SERVICE RESERVOIR.
The Town Council of Aberdeen are prepared to receive

Tenders from Competent

Persons willing to enter into a Contract for the CONSTRUCTION of a CONCRETE COVERED SERVICE RESERVOIR of a capacity of 7 million gallons, at Airy Hall, near Aberdeen.
The Drawings may be inspected and Specification, Schedule of Quantities, and Form of Tender obtained, on and after 27th June, 1924, on application at the Water Engineer's Office, 41½, Union Street, Aberdeen. Early application is desirable, and no specification will be given out after 5th July.
For each Specification a deposit of Five Pounds Sterling will be required, which sum will, after a Tender has been accepted, be returned to the Tenderer, provided that he shall have sent in a *bona-fide* Tender, based on the drawings, specification and schedule of quantities provided, with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.
The employment of labour shall be in accordance with the revised conditions of the Unemployment Grants Committee.
Tenders on the Forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for AIRY HALL RESERVOIR," are to be addressed to the undersigned. No Tender delivered after Noon on 16th July, 1924, will be considered.
The Town Council do not bind themselves to accept the lowest or any Tender.
GEORGE MITCHELL, M.Inst.C.E., F.C.S.
Water Engineer's Office,
41½, Union Street, Aberdeen.
17th June, 1924. F 74

BOROUGH OF PORTSMOUTH.

WIDENING OF THE CAMBER.

NEW QUAY WALL.

The Portsmouth Town Council invite

Designs and Tenders for

the CONSTRUCTION and MAINTENANCE in thorough repair for twelve calendar months from the completion thereof, of the following WORKS, that is to say :—
The Widening of Portsmouth Camber near the end of East Street, Portsmouth, by the removal of the projecting quay wall there, and the construction of a New Quay Wall and other Works in connection.
Copies of the General Drawings, Conditions and Specification under which Tenders are invited, can be obtained on application (accompanied by the sum of £3, which will be refunded on the return of the documents within seven days, or on the receipt of a *bona fide* Tender, accompanied by the documents required) to Mr. ARTHUR W. WARD, the Borough Engineer, Town Hall, Portsmouth, from whom any further particulars can be obtained.
The work will have to be carried out under the requirements of the Government Unemployment Grants Committee and the Trade Union Rules in force in the Borough.
Each Tender must be accompanied by detail drawings, specification and priced quantities of the Scheme submitted by the person tendering.
Tenders marked, "Tender for Widening, Portsmouth Camber," are to be sent in on the form supplied, and must reach the undersigned not later than TEN a.m. on Tuesday the 12th August, 1924.
The Council do not bind themselves to accept the lowest or any Tender.
F. J. SPARKS,
Town Clerk.
The Town Hall,
Portsmouth.
23rd June, 1924. F 141

THE SOUTH INDIAN RAILWAY COMPANY, LIMITED, are prepared to receive

Tenders for the Supply of :—

1. HELICAL and VOLUTE SPRINGS.
2. WELL CURBS and CAISSONS for Perok and Kallagi Bridges.

Specifications and Forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W.1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Helical and Volute Springs," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 18th July, 1924.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of :—
2s. 6d. for each copy of Specification No. 1.
£1 for each copy of Specification No. 2.
Copies of the drawings may be obtained at the Offices of Messrs. ROBERT WHITE & PARTNERS, Consulting Engineers to the Company, 3, Victoria Street, Westminster, S.W.1.
A. MUIRHEAD,
Managing Director.
91, Petty France, S.W.1.
26th June, 1924. F 176

LOCHABER WATER POWER.

CONTRACT NO. 2.

THE NORTH BRITISH ALUMINIUM COMPANY LIMITED is prepared to receive

Tenders for the Construction

of an AQUEDUCT between LOCH TREIG and FORT WILLIAM, INVERNESS-SHIRE, including 15 miles of PRESSURE TUNNEL with INTAKE SHAFTS and OTHER WORKS in connection therewith.
Persons desiring to Tender may obtain, on and after the 30th June, 1924, from the Company's Engineers, Messrs. C. S. MEIK & BUCHANAN, 16, Victoria Street, Westminster, S.W.1, copies of the drawings, specification, Form of Tender, etc., upon payment of £5 (by cheque), which will be returned upon receipt of a *bona fide* Tender together with the drawings supplied.
Inspection of the ground may be made up to but not after the 31st July.
Preference will be given to Contractors on the King's Roll and who are prepared to employ 75% of ex-service men.
Sealed Tenders endorsed "Lochaber Water Power Contract No. 2," addressed to the SECRETARY, The North British Aluminium Company, Limited, 109, Queen Victoria Street, E.C.4, must be received before Ten a.m. Monday, 1st September, 1924.
The Company does not bind itself to accept the lowest or any Tender.
G. W. JEFFERY,
Secretary. F 167

COUNTY BOROUGH OF EAST HAM.

TO HEATING AND HOT WATER ENGINEERS.

The above Council invite

Tenders for the Supply and

ERECTION of HEATING and DOMESTIC HOT WATER SUPPLY PLANT, including alteration to the Existing Plant, at the Isolation Hospital, East Ham. Tenders must include for the whole of the work specified and not for sections only.
Plans and specifications may be inspected either at the Borough Engineer's Office at the Town Hall, East Ham, E.6, or at the office of the Consulting Engineer, Mr. T. J. R. KIERNAN, B.Sc., M.Inst.C.E., 17, Victoria Street, S.W.1, between the hours of Ten a.m and Four p.m. (Saturdays excepted) and copies thereof can be obtained on application to the Borough Engineer, such application to be accompanied by a deposit of Two Guineas which will be returned on receipt of a *bona fide* Tender.
Sealed Tenders endorsed "Heating and Hot Water Supply Plant, Isolation Hospital, East Ham," are to be addressed to His Worship the Mayor, Town Hall, East Ham, E.6, and delivered not later than Ten a.m. on Thursday, 10th July, 1924.
The Council do not bind themselves to accept the lowest or any Tender, and will not defray any expenses incurred in connection with Tendering.
By Order
O. RUSTAGE WILSON,
Town Clerk.
Town Hall,
East Ham.
June, 1924. F 156

APPOINTMENTS OPEN.

THE UNIVERSITY OF SHEFFIELD.

ASSISTANT LECTURESHIP IN MATHEMATICS.

The Council are about to appoint an

Assistant Lecturer in

MATHEMATICS, preference to be given to a candidate who has had experience with Engineering students. Salary £350 per annum. Further particulars may be obtained from the undersigned, with whom applications should be lodged by July 7th.
W. M. GIBBONS, Registrar. F 52

COUNTY BOROUGH OF BELFAST.

MUNICIPAL COLLEGE OF TECHNOLOGY.
Principal; JOHN HARLS, B.A.

The Belfast Education Committee invite

Applications for the Position

of PROFESSOR of PHYSICS and ELECTRICAL ENGINEERING at the Municipal College of Technology, Belfast.
The salary attached to the position is £600 per annum, rising by annual increments of £25 to a maximum of £750 per annum.
Particulars of the Duties and Conditions of Appointment may be obtained from the undersigned, with whom applications, on the special Form provided for the purpose, must be lodged not later than Saturday, 5th July, 1924.
The duties of the position commence on the 1st September next.
Applications should be accompanied by copies of three recent testimonials. (Original testimonials must not be sent.)
The appointment will be subject to the condition laid down by the Ministry of Home Affairs, copy of which may be had on application.
CANVASSING IS STRICTLY FORBIDDEN AND WILL DISQUALIFY.
RUPERT STANLEY,
Director of Education. F 51

LITERATURE.

Payment by Results: Introduction, Organisation, Rate fixing. By J. E. POWELL, London: Longmans, Green and Co., 1924. [Price 21*s.* net.].

THIS volume is a valuable addition to the literature connected with a subject that is much misunderstood and has been distorted by controversy. As will be very generally known, the author has acquired his knowledge at first hand in a variety of works, and has given the subject much thoughtful attention. His conclusions and his reasoning alike are to be commended to those who are apt to give judgment on insufficient grounds, in which sentiment takes the place of intelligent inquiry, and interested motives are allowed to outweigh the decisions of true economy.

The system of payment by results or the adoption of means for inducing a larger output on the part of the workmen by offering opportunities for increasing earnings, suggests an apparently simple and logical agreement between employer and employee, by which labour is assured of an adequate remuneration, in proportion to the quantity of work done in a specified time. A weak point is that the agreement starts on the assumption that an artizan, working for wages, will not fulfil his contract without a bribe, or alternatively, that time wages are fixed and regulated by the performance of the least skilful and energetic of the workmen. Mr. Powell does not mention trades unions or discuss their tactics, but the impression is abroad that the general policy of these tribunals is to secure the recognised payment to the least competent or the most indolent. If this policy has been successful it is evident that in self-defence the employers must adopt some measures for enlisting the active co-operation of the more energetic and skilful.

What, then, are the means to be adopted that will satisfy both parties to the agreement, increase output, reduce cost in facing severe competition, and ensure amicable relation between labour and capital. It may be that incompatible conditions exist, and no completely satisfactory solution is possible, but the problem should be discussed in a dispassionate manner and the complaints made by either side examined, with the view of discovering their origin and remedy. Such a course is the more necessary, because the prevailing conditions are the consequences of many operating factors, obscuring the true issue. Mr. Powell's experience leads him to the belief "that the average workman and the average manufacturer are reasonably honest men," and that much of the distrust surrounding the project of payment by results arises from a superficial and perverted view of the economic conditions. The correct course to pursue in order to induce greater exertion on the part of the worker may be to offer a higher remuneration, but to assume that low output is necessarily a consequence of the indolence of the worker is possibly wrong, while to offer higher payment, constructively as a bribe, may be injudicious and end with making future manufacture too expensive.

On the other hand, the complaint of the workman that job rates are cut by greedy employers and that continuity of employment is injuriously affected is probably an unwarranted misrepresentation, founded on the occurrence of isolated cases, which are made to represent the policy of a class. In carefully considered and impartial reports it has been pointed out that the difficulty in fixing piece rates is due to the fact, that the men work slowly so long as the job produced is on time rate, in order to obtain the fixing of a higher piece rate work. The author illustrates this point by instances drawn from his experience, but here again examples must not be confounded with principles. That both sides to the bargain find that the scheme of payment by results leaves something to be desired suggests that the dissatisfaction is elemental, and that its origin must be sought in economic causes.

If the right remedy is not applied, or is applied in the wrong way, an evil may be introduced greater than that sought to be removed, and the firm threatened with extra charges that it is well nigh impossible to reduce. Since workmen's energies and willingness to produce are variable quantities, some form of payment by results such as those designed by Rowan, Halsey-Weir or Taylor, schemes concerning which the author gives much well digested information, may be legitimate and beneficial. But if low output is traceable to faults of organisation or inefficient supervision, output will be little increased by the exhibition of greater individual energy, however much encouraged by bonus or premiums. Further, if both higher remuneration and improved organisation are introduced simultaneously, the credit of the better return is liable to be attributed to the wrong cause, and either side is provided with an argument for the promotion of its own ends.

Correct diagnosis is by no means easy, for many factors enter and react on each other, but where the piece-work system has not given satisfaction it will generally be found that the failure is due to costs having been placed too high, because job rates were miscalculated, and when the job rate was reduced in order to make results more equitable discontent followed and restriction of output was resorted to. It cannot be too insistently urged that the job rates, that is, the amount of money fixed as the rate of remuneration to be paid for the completion of a given piece of work cannot stand for rate of output, and also afford opportunity for earning increased weekly wages at the same time. The main object of the scheme is to standardise the job rates so that a man of average ability shall be able to earn 33⅓ per cent. extra pay. To fix this arrangement to all classes of work is a hard task, because the scheme to be effective demands a similar increase of output. If no such increase follows, then payment by results necessitates extra labour cost, and in some classes of work, as in planing where the feed and depth of cut are known, if the job rate is accurately estimated, there is little scope for reducing the time or increasing the pay.

On all grounds of efficiency, equity, control and cost, a standard of performance is to be desired. The authors contribution to this end, one to which he devotes one-third of his book, is to analyse the factors of production in a very minute manner. He pursues the subject through the many operations that occur in engineering works, as drilling, facing, reaming, shaping, planing, &c., providing a mass of information which, if it will not ensure efficiency of output, places accurate estimates at the command of the management.

Shirley Institute Memoirs. Vol. II. 1923. Published by the British Cotton Industry Research Association, Didsbury, Manchester.

THE Shirley Institute is rapidly demonstrating its usefulness and its competency. Recently founded under the auspices of the British Cotton Industry Research Association to investigate problems connected with textile manufactures, the published volumes of Memoirs show progressive activity both in extent and depth of research, demonstrating originality and thoroughness. In this volume, comprising the results of one year's work, thirty-two distinct investigations that have occupied the staff are described, each of these having reached a stage at which useful report could be made, though some indicate the necessity for further research.

Several papers in this collection are summaries and criticisms of earlier discussions of some of the aspects of cotton treatment, and we are by no means inclined to regard these as the least important of the contributions. Much of the information in its original form is inaccessible; another portion is out of date by reason of more recent research; confusion often introduced by variation in terminology through lapse of time is avoided; increased information due to progress in other sciences, particularly biology, is provided, and improved methods of manufacture are indicated and described. These summaries, too, have the effect of banishing what is effete, of confirming what is valuable, of showing where further investigation may prove profitable, and of preventing unnecessary repetition. The attached bibliographies attest to the thoroughness of the examination and the comprehensiveness of the survey.

The remaining papers are fairly well distributed among the chemical and physical, the botanical and biological aspects, of the raw material Generally they are of a highly technical character, that will be much appreciated by those engaged in the textile industries. It is impossible to mention all of these and it might appear invidious to select some, but as an example on the chemical side, some reference may be made to a paper by Dr. R. G. Fargher and Mr. M. E. Probert on the nature of the benzene extract of American cotton, a frequent source of trouble both in spinning and bleaching operations, that has been too little studied. The physical properties have long been recognised more or less accurately, and the removal of the "wax" has been attempted, but its composition has remained undetermined and the methods hitherto applied do not appear to have been either suitable or exhaustive. Without entering into any details of the careful manipulation that eliminated the chances of error arising from possible saponification, or the inclusion of materials other than wax, and therefore outside the inquiry, it must suffice to say that the procedure of the authors was successful. Very definite conclusions have been drawn. A new alcohol, gossypyl alcohol, has been identified and described. Montanyl alcohol was also found, and its formula accurately determined; small amounts of other alcohols are shown to be present and a mixture of phytosterols occur in small quantities. Further, triacontane and hentriacontane have been isolated. This analytical work does not only throw much new light on the chemical constituents of the plant cuticle, but has a definite and practical bearing on the problems of the removal of the wax in the scouring process. Needless to say, it is one of the inquiries to which much more study and experiment will be devoted.

The papers on physical subjects show that the mathematical physicist has been at work, and his assistance can be warmly welcomed, as, we believe, it will be richly rewarded. An especially illustrative contribution is that of Messrs. F. D. Farrow and G. Morris Lowe on the flow of starch paste through capillary tubes, a problem intimately connected with successful sizing. The question before the authors is a preliminary one, whose solution would decide whether the viscosity of a starch paste is a definite physical quantity. The paper describes the experiments carried out with the object of defining the nature of the measurements which are required to determine the fluid properties of starch paste. The results are very difficult of interpretation, and the indications derived from different viscometers appear to be accurate only for differential, and not absolute measurement.

Mr. H. J. Denham continues his researches on the structure of cotton hair and brings to light new features bearing on the general theory of cell wall structure. It is noticeable that the author has not been able to confirm the conclusions of Balls and Hancock on this elemental question, or to accept their interpretation of the facts presented. Mr. Denham, in his anxiety that no suspicion should attach to his microscopical work, gives a description of his methods of use and also of the elementary theory of formation of microscopic images of cotton and vegetable fibre. The discrepancies, however, to whatever cause they may be attributed point to the necessity of collecting further information on fresh lines, which might well be undertaken at the Shirley Institute.

The technological side may be illustrated by a reference to the investigation in cotton fabrics of the presence of "neps," that is, clusters of short, folded, immature hairs which fail to absorb either the dye, or the mordant, or both, and by this resistance give rise to unsightly lighter motes clearly seen on the dyed background of the finished product. Some of the defects as motes, may have a mechanical origin, as the result of a loose end of yarn being pushed to one side and exposing a white patch below, but in the case of "neps" the general conclusion assigns this defect to the presence of a matted tangle of thin walled hairs, essentially of the type known as "dead cotton." The thin walled hairs occur in many varieties, especially in Sea Island cotton, and their occurrence must be considered as genetic, giving rise to an annoyance that can be removed only by careful weaving and the elimination of abnormal strain. We should have liked to have called attention to many other papers, but

we hope to have indicated the wide extent of the ground covered and the successful and unwearying industry of the staff.

BRITISH EMPIRE EXHIBITION: WATERWORKS APPLIANCES.—II.

AMONG the well-known firms showing small fittings such as valves, hydrants, &c., is Messrs. Guest and Chrimes, Limited, of Rotherham. This firm's exhibit includes a display of water meters, arranged in glass cases so as to make the mechanism visible. Examples are thus shown of Chrimes Turbine water meter which the firm has now manufactured for over 60 years, and we understand with such satisfactory results that meters put into service that number of years ago, are still working accurately though examined and overhauled only about every six or seven years in the interval since. A new pattern of Fan water meter is also shown at this firm's stand. This is illustrated in Figs. 12 to 14 annexed. The whole of the mechanism of this meter is of nickel or nickel-plated. The fan is arranged in the base and is mounted on a spindle in agate bearings offering very little resistance to the flow so that the loss of head is reduced to a minimum. The water enters the meter in a direction tangential to the fan blades, and a feature of the meter is the stationary regulating blade fitted above the fan, near the outlet. This blade can be adjusted from the outside of the meter by means of a screw driver, by which its inclination may be modified so as to affect the swirl in the meter chamber. By this adjustment a very high degree of accuracy of registration can be secured. Fig. 13 shows the position, in the side of the case, of the head, by means of which the deflecting blade is adjusted.

The exhibits of Messrs. J. Blakeborough and Sons, Limited, occupy part of the same stand as those of Messrs. George Kent, Limited, to which we referred in our last issue (page 785), the two firms being associated in business. Messrs. Blakeborough's exhibits include a variety of valves for numerous purposes. Among these will be found an example of the Edwards self-closing valve for water mains, illustrated in our issue of February 23, 1923 (page 235), when we gave a description of a 54 in. valve of this type. These valves are placed at the throat of a Venturi tube, the pressure difference being employed to actuate a trip which sets in operation an hydraulic gear by which the valve is closed, the movement being slowed down as the shut position is approached. The valve has an unobstructed waterway when open. Another pattern of valve is shown electrically operated, the valve spindle being fitted with ball thrust-washers for both directions and the drive incorporating a friction clutch which prevents the motor being overloaded either through failure of the limit switches, or through an obstruction holding the valve open. The limit switches are self-resetting and cut out the motor at the top or bottom of the valve travel. All gears run in an oil case or grease box. The valve may be operated by hand by a wheel provided with a clutch so that when the valve is worked by the motor, the wheel is idle and does not revolve. In addition to various examples of standard sluice valves, the firm has also on exhibition automatic exhaust relief valves for condensers, reducing valves, hydrants, examples of Coxon instantaneous closing steam valves, &c. Messrs. Blakeborough are licensees for the Larner-Johnson type of valve used extensively for hydro-electric and other work, and a model of the valve is shown at the Exhibition. This type of valve was illustrated and fully described in our issue of July 14, 1922 (pages 34 and 35) in connection with 14 ft. valves installed at the Queenston power station of the Hydro-Electric Power Commission of Ontario. Since then valves up to 22 ft. in diameter have been constructed for the enlargement of the Niagara plant, and the valve has been extensively adopted for both large and small sizes. Of rather more novelty is the Lundgren-Boyd rotary valve which is to be seen at Messrs. Blakeborough's stand, and which we illustrate in Figs. 15 to 18 opposite. The arrangement illustrated shows a valve with hydraulic operating

WATERWORKS APPLIANCES: EMPIRE EXHIBITION.

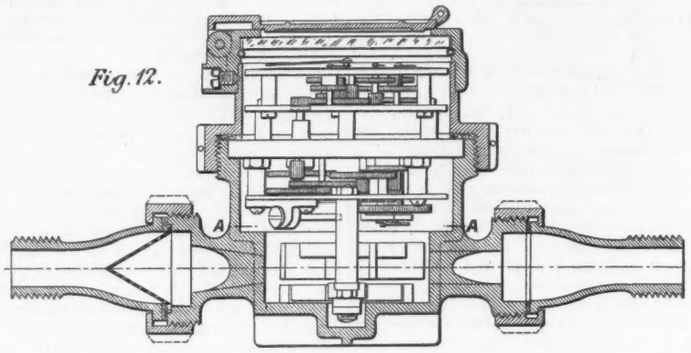


Fig. 12.

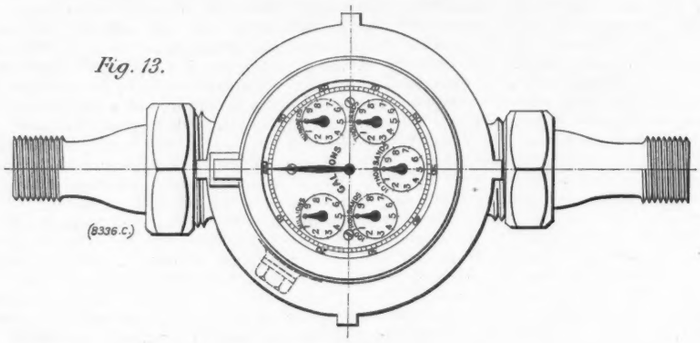


Fig. 13.

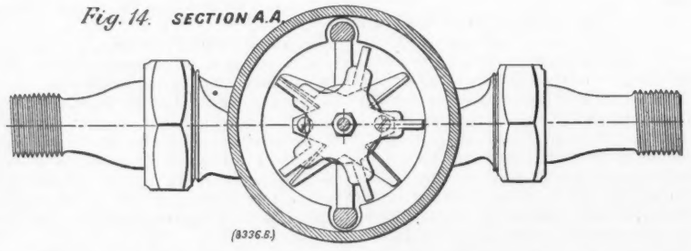


Fig. 14. SECTION A.A.

FIGS. 12 TO 14. FAN TYPE WATER METER; MESSRS. GUEST AND CHRIMES.

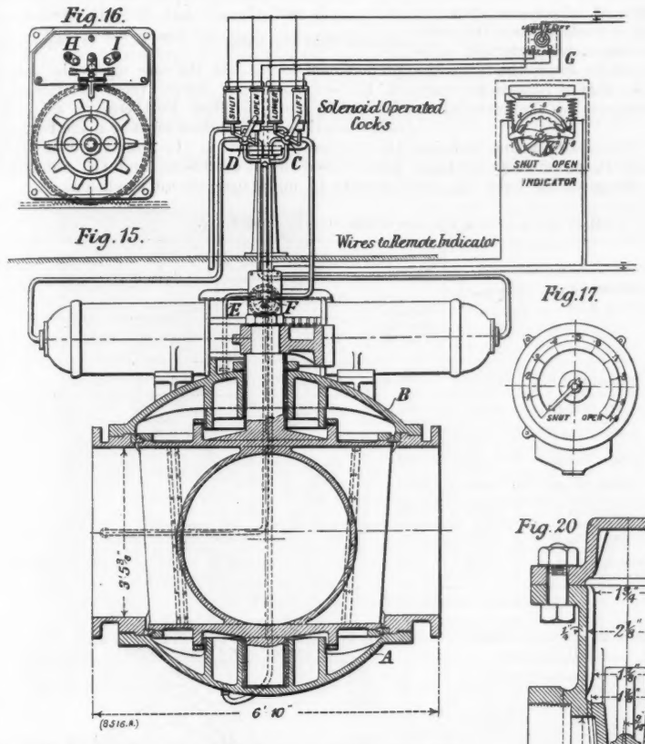
cylinder for remote control, the valve being one for turbines of hydro-electric installations.

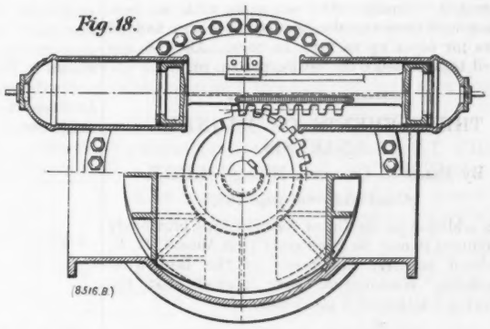
The Lundgren-Boyd valve consists of a large plug which can be rotated through 90 deg. in its conical casing. In order to make this movement possible, and yet retain watertightness, the plug is forced down into its conical casing when set, and lifted again before being turned afresh. Figs. 15 to 18 show the main features of a 1,050 mm. (41⅜ in.) valve. The large plug, shown in the closed position in Fig. 15, is carried by trunnions, on which it rotates, in the covers A and B. To lift the valve before turning, pressure is exerted in the space between the cover A and the bottom of the plug, while the space above the plug and under the cover B is open to the exhaust. To force the plug home again after turning, pressure is admitted above the valve plug, and relieved below it. The turning mechanism will be clear from Fig. 18. Two single-acting horizontal hydraulic cylinders are furnished, the two pistons being connected by a single rod on which is cut a rack, meshing with a toothed quadrant keyed to the valve spindle. The piston rod is provided with a support opposite the point of contact of the rack and quadrant, and stops are provided to limit the quadrant movement. In the closed position a gun-metal face on the downstream side of the plug is wedged against a corresponding face of the valve body as shown in Fig. 18.

Two control cocks are used, one for lifting and forcing down the plug, and the other for turning it. These cocks are shown at C and D in Fig. 15. The former is used to lift the plug and force it down again, and the latter to turn it. Both cocks are of the four-way type, and both have connections for pressure water from the main, and also to the exhaust. In the position shown for the cock C, pressure is applied below the plug, the space above it being opened to the exhaust, through a cushioning connection E and valve F. The cushioning effect is produced by the valve F being gradually closed by the plug spindle as the plug approaches the full lift. When lifted, the plug is turned by operating the handle of the cock D. To close the valve the cock D is first turned to bring the valve to the closed position, and the cock C is then thrown over so as to produce pressure above the plug and force it home in its casing. The operations are practically fool-proof and no harm can come if the wrong handle be turned first.

Our illustration shows the valve fitted with remote control and indicating gear. This gear involves the use of four solenoids working in conjunction with the handles of the cocks C and D, two being for easing and two for turning. The control switch G has only one handle and can rotate only in one direction. From the position shown the handle, moving clockwise, first works the lifting solenoid of the cock C. Further movement of the handle operates the "Opening" solenoid of the cock D. The next move of the handle works the "closing" solenoid of D and the completion of the circle works the "lowering" solenoid of the cock C. The indicator gear is worked by a small circular contactor shown in Fig. 15 behind the cushioning valve F, but to a larger scale in Fig. 16. This gear is worked by a tooth wheel in mesh with a small rack carried by the piston rod, this wheel making

WATERWORKS APPLIANCES AT THE BRITISH EMPIRE EXHIBITION.





FIGS. 15 TO 18. THE LUNDGREN-BOYD VALVE; MESSRS. J. BLAKEBOROUGH AND SONS, LIMITED.

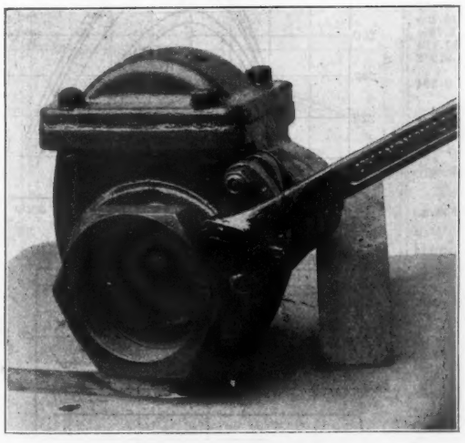
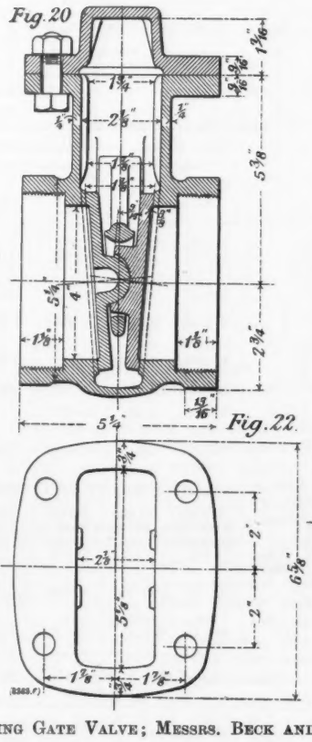
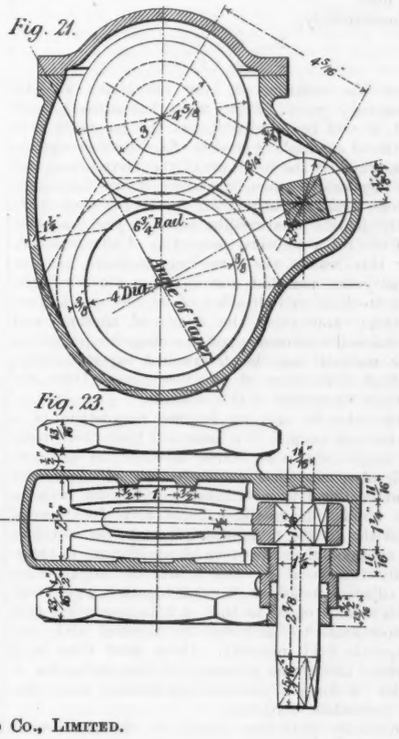


FIG. 19.





FIGS. 19 TO 23. QUICK-ACTING GATE VALVE; MESSRS. BECK AND CO., LIMITED.

one complete revolution for a 90 deg. movement of the main valve. On the spindle of the tooth wheel is a star wheel having ten points, and these in revolving strike an arm suspended above and make contacts at H and I, according to the direction in which the rack is moved. The making of these contacts operates the indicator mechanism shown at K, the pointer of which shows in ten steps the position of the valve. The indicator dial is shown in Fig. 17. The operator can thus see at any time the actual position of the valve and can observe whether it responds to his actions, or is blocked and prevented from operating properly. The indicator is also of service in advising him of the completion of the turning operation so that he may move the control handle to the "lower" position, to press the plug home.

It will be noticed from the drawings that gun-metal sleeves and faces are provided for the plug, spindle, &c. Pressure is maintained inside the cylinders and covers by means of cup leathers. When the valve is open there is no obstruction to the flow and no pockets cause eddying. The valve faces are protected, and internal parts may be withdrawn without disturbing the pipe line. The small preliminary leakage past the valve when it is lifted is sufficient to transmit pressure to the turbine before any considerable flow takes place.

In our article of last week we referred to some of the exhibits of Messrs. Beck and Company, Limited, Southwark. Another of Messrs. Beck's appliances, which for convenience we may notice here, is a quick acting gate valve, known as the "Handy" valve, giving a clear opening equal to the bore of the pipe. It is especially suitable for controlling the flow of light and heavy fluids in refineries, breweries, gas works, &c., as well as for low-pressure steam and hot water in connection with heating appliances. When fitted with a nipple and elbow, it is also well adapted for use as a bib cock for emptying tanks and vats. The appearance of one of the valves constructed of gun-metal and provided with female screwed connections, is illustrated in Fig. 19 on this page, while the details of the design and construction can be followed from an examination of the accompanying Figs. 20 to 23, with but little explanation. As will be seen, the valve proper consists of two discs connected by a form of ball and socket joint and arranged so that they can be wedged into the tapering space between a pair of flat seatings or withdrawn into the upper part of the body, clear of the inlet and outlet openings. The movement of the valve discs is effected by an external hand lever mounted on a spindle which passes through a packed gland in the body, as shown in Fig. 23. The spindle carries a short arm terminating in a ring which encircles the bosses of the valve discs forming the ball and socket joint, so that the discs can be moved from the closed to the full-open position by

turning the lever through an angle of 60 deg. The valve will, however, remain in any intermediate position, the extent of the opening being sufficiently indicated by the position of the external lever. The dimensions given in Figs. 20 to 23 are for a 4-in. valve, which is the largest size made of the form illustrated. Similar valves are made with cast-iron bodies, and these can also be supplied with a flanged joints for pipes up to 9 in. in bore. All sizes are tested to a pressure of 100 lb. per sq. in.

THE ELEMENTS OF MAGNETIC ANALYSIS.

By ELLIS H. CRAPPER, M.Eng., M.I.E.E.

(*Concluded from page* 788.)

IN addition to the linear relationships previously introduced it may be mentioned that Messrs. R. L. Sandford and W. L. Cheney of the Bureau of Standards, Washington, have proved that the following relationships also exist :—

$$\frac{H_m}{B_r} = a_1 + \beta_1 H_m \quad . \quad . \quad . \quad (1)$$

and

$$\frac{H_m}{H_c} = a_2 + \beta_2 H_m \quad . \quad . \quad . \quad (2)$$

in which a_1 and a_2 are the intercepts on the axis of the ordinates, and β_1 and β_2 are the slopes of the lines.

Consequently,

$$\frac{H_c}{B_r} = \frac{a_1 + \beta_1 H_m}{a_2 + \beta_2 H_m}$$

gives the measure of the reluctivity at the remanency point. From what has already been said, it will be admitted that the magnetic properties of a sample of steel are fixed by its constitution, which is the resultant of the composition and the physical treatment to which it has been subjected; consequently there must be some perfectly definite relationship between the magnetic and the other physical properties of the material. For this reason the American engineer has for some years accepted certain magnetic constants of a steel as an indication of its mechanical properties; and since the *effects* of thermal and mechanical treatment upon the magnetic properties of a material may be determined experimentally, without destruction of the test pieces, there is a distinct advantage in this method.

In order to account for the magnetism of a permanent magnet it is assumed that there must be magnetic ties or bonds between the different molecules, so that magnetisation is the effect representing a type of static equilibrium between the applied magnetising force and the thermal activities of the molecules. It may, for instance, be assumed that the state of equilibrium is materially influenced by the action of neighbouring or adjacent molecules, bonded together, as it were, with a force equal to that of a homogeneous field proportional to, and equally directed with, the magnetic field intensity. There must then be a certain favourable grouping of the molecules in order to form a certain and definite molecular, or crystalline, structure.

Kennelly puts this phase of the problem as follows: "Magnetisation results from, and is accompanied by, a particular kind of stress. Magnetic materials when submitted to this stress, not only intensify it, but are strained, in such a manner as to sustain the stress indefinitely, after the force (cause) has been removed. The effect of the stress is to influence the molecular structure or molecular motion, and electro-magnetic energy is stored. This stress forms closed paths and is a circuital quantity, possessing intensity as well as direction. Thus, the uniform intensity of flux in a solenoid excites in the iron, when introduced, a uniform M.M.F. which will exist in every centimetre of iron under stress along the circuital path. Since the prime M.M.F. has increased μ times, the induced M.M.F. in the iron, must be $\mu M - M = M(\mu - 1)$, which is an induced M.M.F."

Attention has already been drawn to the fact that the constant a in Fröhlich's equation is indicative of the magnetic hardness of the material, whilst the constant b is the reciprocal of the saturation value of the intensity of magnetisation; consequently, the constants a and b will indicate differences in the composition and heat treatment of the samples. Thus, in the case of eight samples of low permeability cast iron—the constants of which are given in Table VIII—an attempt is made to state the order of the *hardness* of the respective materials. The reciprocal of b, *i.e.*, B_s will be *larger* the softer the material; similarly, the value of μ_{max} is inversely proportional to the hardness of the material as shown in Fig. 18.

Furthermore, since the relationships existing between the flux-density B, or intensity of magnetisation I, and the magnetising force H, are hyperbolic, such relationships are fixed by the magnetisability of the material, *i.e.*, $B_s - B_r$, or $I_s - I_r$; consequently, the magnetisability per unit of the remanent value B_r or I_r, *i.e.*, $\frac{I_s - I_r}{I_r}$, is an important constant of a magnetic material and its condition. In connection with this phase of the subject, attention is called to the series of curves given in Fig. 19, depicting the values of I_{max}, I_r, $(I_{max} - I_r)$ and $\frac{I_{max} - I_{r1}}{I_{r1}} \times H_c$, for 12 tungsten-steel magneto-magnets selected from a group of high-quality magnets, in which H_c varied from 67·7 to 76·4 C.G.S. units. Whilst there are slight differences in the individual values of I_{max}, I_r and $(I_{max} - I_{r1})$, it is interesting to observe that the value of $\frac{I_{max} - I_{r1}}{I_{r1}}$ is inversely proportional to H_c. In the case where the values of H_c are somewhat lower, these relationships are slightly more variable. Furthermore, as previously mentioned, distinction must be made between the normal constant I_r (*i.e.*, remanent-intensity under closed-circuit conditions) and the remanent-intensity I_{r_1} under open-circuit conditions.

TABLE VIII.—DATA RE LOW-PERMEABILITY CAST IRON.

Sample.	Fröhlich's Equations for $\frac{1}{\mu - 1} = a + b\,H$	$B_{is} = \frac{1}{b}$	μ_{max} From μ Curves, Fig. 18.	μ_{max} Corresponding to H μ	μ_{max} Corresponding to B μ	Order of Hardness* from a	Order of Hardness* from B_{is}	Order of Hardness* from μ_{max}
A.	0·0025594 + 0·000076082 H	13143·7	273·3	15	4,110	6	5	5
B.	0·0020581 + 0·00007407 H	13501	302	14·5	4,379	3	2	2 or 3
C.	0·0025527 + 0·000077445 H	12912·4	268	15	4,020	5	8	6
D.	0·0020638 + 0·00007731 H	12934·9	290	15	4,350	4	7	4
E.	0·0029287 + 0·00007506 H	13322·6	217	17·5	3,798	8	4	8
F.	0·0020403 + 0·00007404 H	13506·2	309	14·5	4,481	2	1	1
G.	0·0027855 + 0·00007659 H	13056	232	16	3,712	7	6	7
H.	0·001883 + 0·00007505 H	13324	302	15	4,530	1	3	3 or 2

* The harder the material the higher the number.

TABLE IX.—*Tungsten Steel Magneto-Magnets.*
Value of H_{max} = 400 C.G.S. units.
(Samples from the same ingot.)

	A.	B.	C.	D.	E.
H_c ..	71·54	71·42	71·8	70·92	31·27
B_{max} ..	13,970	13,850	13,930	14,410	17,385
I_{max} ..	1,079·5	1,070	1,076	1,115	2,735
B_r ..	9,221	9,101	9,022	9,661	11,479
I_r ..	733·6	724	718·74	768·6	913·2
$c = \frac{I_r}{I_m}$ ..	0·6795	0·6766	0·6668	0·6896	0·334
$\frac{H_c}{I_r}$ ..	0·0975	0·0986	0·1	0·0922	0·0341
$H_c \times c$ ..	48·6	48·33	47·88	48·92	10·44
$\frac{I_m - I_r}{I_r}$ ..	0·471	0·478	0·497	0·45	2
$\frac{H_c}{c}$ ..	105·3	105·5	107·8	102·8	96·3
$\frac{H_c}{I_{max}}$ ..	0·06627	0·06675	0·06671	0·06363	0·0114
$(\beta\phi)_{max}$ ..	299,200	302,000	296,500	321,000	151,000
a ..	0·002797	0·0028296	0·0039476	0·00327	0·01732
b ..	0·0000668	0·0000677	0·000064	0·000063	0·000694
I_s (calculated)	1,191	1,175	1,243	1,257	1,441
$\frac{a}{b}$ ..	41·87	41·79	61·65	51·9	24·92
Quenched at	825 deg. C.	825 deg. C.	875 deg. C.	775 deg. C.	As made

TABLE X.—*Values of Magnetic Energy per Cubic Centimetre.*

Material.	Condition.	Ergs per cub. cm.	H_c.
Lowmoor iron	Annealed ..	183	2
Mild steel	Hardened ..	970	7
Pianoforte wire	Hardened ..	5,600	41
Silver steel	Rolled ..	2,500	18
	Hardened ..	7,900	68
Tungsten steel	Annealed ..	3,900	18
	Rolled ..	5,300	28
	Hardened ..	13,100	67

Fig 18. PERMEABILITY CURVES FOR LOW PERMEABILITY CAST IRON.

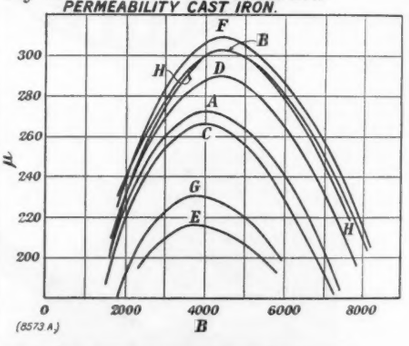
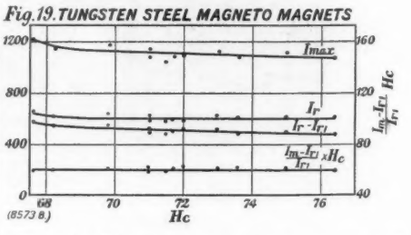


Fig.19. TUNGSTEN STEEL MAGNETO MAGNETS



The reluctivity or coercive-force per unit of remanent intensity—*i.e.*, $\frac{H_c}{I_r}$ —at the remanency point, is indicative of the ability of the finished magnet to withstand shocks and the effects of armature-reaction, in the case of magneto-magnets when the magneto operates, and thus provide the M.M.F. capable of producing the required magnetic flux in the armature of the magneto. The effect of a change in the quenching temperature in the case of magnets of the same composition must be carefully noted, and a series of primary and derived constants are given in Table IX, which will prove not only useful but instructive.

In addition to what has already been stated with respect to the fact, energy is absorbed by steel during the process of magnetisation in consequence of molecular friction, with which is associated magnetic hysteresis, *i.e.*, the tendency to persist in a given magnetised state, or the *lagging behind* of the magnetisation relatively to the magnetising-force. Hysteresis is one of the factors which dominates the form and size of the complete loop

of the cyclic diagram, and thus fixes the magnitudes of the remanent intensity, and the coercive-force. The dissipation of the energy involved in the cyclic process of magnetisation demands an expenditure of energy which is derived from the magnetising system, and this energy loss in ergs per cub. cm. per cycle is given by $E = \eta B_{max}^{1\cdot6}$, in which η is the Steinmetz *coefficient of hysteresis*, the magnitude of which depends upon the nature and condition of the material.

In the case of carbon and tungsten steels, the

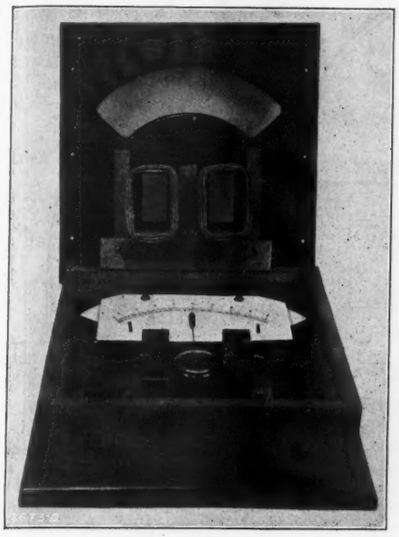
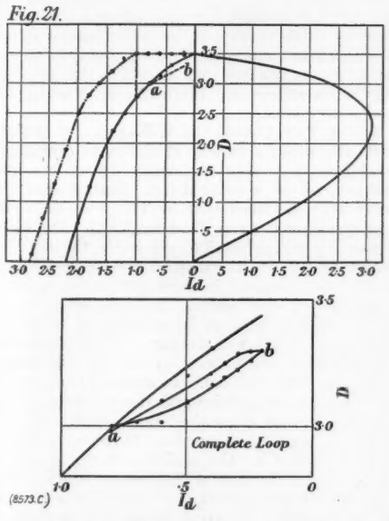


FIG. 20.

Fig. 21.



following are representative values of the coefficient, η :—

Carbon steel—

0·84 per cent. ... $\eta = 0{\cdot}045$; $H_c = 58$; $\frac{H_c}{\eta} = 1289$

1·21 per cent. ... $\eta = 0{\cdot}0356$; $H_c = 53$; $\frac{H_c}{\eta} = 1489$

Tungsten steel—

C = 0·59, W = 5·5 (annealed) ... $\eta = 0{\cdot}0157$; $H_c = 26$; $\frac{H_c}{\eta} = 1656$

C = 0·59, W = 5·5 ... $\eta = 0{\cdot}052$; $H_c = 73$; $\frac{H_c}{\eta} = 1404$

C = 0·76, W = 2·7 ... $\eta = 0{\cdot}0483$; $H_c = 69$; $\frac{H_c}{\eta} = 1429$

General values of the magnetic energy per cub. cm. associated with different types of iron and steel are given in Table X, on page 816.

The measures of the magnetic energy available in the case of magneto-magnets, in terms of the β–ϕ curves, obtained by taking the products of the consecutive values of the flux-density and the associated values of H_d of the demagnetisation portion of the hysteresis loop, shown in Fig. 15, page 787 *ante*, give, what Evershed designates the $\beta\,\phi$ curve, the maximum value of which *i.e.*, $(\beta\,\phi)$ max., is the measure of the maximum magnetic energy available, expressed as $\frac{(\beta\,\phi)_{max}}{8\,\pi}$ ergs. The $\beta\,\phi$ product not only enables one to ascertain the minimum volume of steel required to produce a desired result, but forms a reliable figure of merit which differentiates between the different brands of magnet steels. The following are representative values :—

Carbon steels seldom exceed 200,000 for $(B\,\phi)_{max}$
Chrome steels give from 240,000 to 250,000 $(B\,\phi)_{max}$
Tungsten steels give from 280,000 to 300,000 $(B\,\phi)_{max}$
Cobalt-chrome steels give from 700,000 to 750,000 $(B\,\phi)_{max}$
Cobalt (35 per cent.) steel gives about 900,000 $(B\,\phi)_{max}$

It is suggested that the difference in the rate of variation in the intensities of magnetisation may probably be due to the difference in the magnetic elastic properties of the material, and that the constant d in $\frac{\partial I}{\partial H} = d\left(\frac{I^2}{H^2}\right)$ is associated with the measure of the elastic limit of the material. This can only be decided by research.

The writer is not aware that any information associated with the magnetic elasticity properties

TABLE XI.—*Demagnetisation Test for Magnetic Elasticity.*

Demagnetising Current.	Magnetometer Reading.	Reading after opening the Circuit.
Amperes.		
0·2	3·3	3·4
0·4	3·2	3·4
0·5	3·12	3·4
0·6	3·0	3·4
0·8	2·85	3·4
1·0	2·6	3·4
1·2	2·3	3·2
1·5	1·9	3·0
1·8	1·1	2·67
2·0	0·5	2·27
2·3	−0·5	1·6
2·5	−1·3	0·9

of iron and steel has been published, and the following brief note is an account of his work in this direction.

Assuming that the principles associated with elasticity in the mechanical treatment of materials may be tentatively applied in matters magnetic, then the magnetic elastic limit of a permanent magnet is the measure of the maximum stress—demagnetising-force—which can be applied to the magnet without causing any other than purely elastic deformation ; it is suggested that the magnetic elastic limit has not been exceeded, and that the magnet will return to its normal physical state upon the removal of the active stress.

Perfect elasticity exists when a magnet entirely recovers its original state after the distorting cause is removed. From this point of view, magnetic elasticity may be defined as that property of a permanent magnet in virtue of which stress is required to maintain strain. Within the limits of magnetic elasticity, the necessary stress is proportional to the strain, just as distortion is proportional to the distorting force.

In order to investigate magnetic effects associated with open-circuit conditions, the author has used a deflecting magnetometer,* the moving element of which is the armature of a moving-coil ammeter; the general features of the instrument are shown in Fig. 20. The method of procedure adopted to get a measure of the magnetic elastic limit will be apparent from results of a test given in Table XI, and the curves in Fig. 21. The demagnetisation portion of the loop from B_r to H_c was obtained, in the usual manner, by means of the magnetometer after the magnet had been flashed, suitable demagnetising coils being used.

The magnet was then reflashed and placed in position on the instrument, and the demagnetising-force was increased by steps of eight units of negative H. After each reading the demagnetising-force was reduced to zero, and, as shown in the diagram, the magnet recovered its remanency value up to the application of 32 units of negative H. From this point, the recovery fell off regularly until the magnet was completely demagnetised. It is suggested that the magnetic elastic limit of a magnet be expressed by the measure of the maximum value of the demagnetising-force, H_d, through which the magnet recovers its value of B_{r_1} when H_d is removed, expressed as a percentage of H_c.* In the example it was found to be 45·4 per cent.

* Previously referred to on page 787 *ante*.

CENTRIFUGAL MACHINES AT THE BRITISH EMPIRE EXHIBITION.

MANY industrial processes previously carried out in very slow and inefficient ways are now performed by methods depending upon the effects of centrifugal force. Such work as drying, the separation of fluids of differing densities, filtration and the clarifying of an endless variety of substances may be cited as examples to which centrifugal machines have been successfully applied. Not only is the scope of this type of plant extensive, but the number of industries which make use of it is very great. In textile mills the raw material and piece goods are dried by the process and similar work is done in laundries. There are many granular substances produced by chemical action from which the moisture must be removed. For this purpose centrifugal driers find common application. A good example is afforded by the treatment of sulphate of ammonia in the gas works. Water is removed from hides, skins, felts and fleeces by methods that are similar to those in use for drying cloth. In sewage works the activated sludge is dried by centrifugal action, and the preparation of coal for the market is another phase of work in which the centrifugal machine finds satisfactory use. The moisture left on coal after washing can be cheaply and quickly removed by the process. Sugar is purified after crystallisation in plant making use of similar actions. Examples of the machines covering this wide field are on view in the Palace of Engineering of the British Empire Exhibition, and we illustrate some of them on pages 818, 819 and 820 and on Plate LXXXII.

In its simplest form a centrifugal machine consists of a perforated cage, mounted on a vertical spindle and enclosed in an outer safety case, having the top portion of the cage accessible. The wet material is placed within the cage and the machine is run at a very high speed. The great centrifugal forces then developed operate to press the wet material against the side of the cage and force out the water into the surrounding case through the many perforations. Such machines will within a few minutes extract up to 80 per cent. or so, of the water or liquid they contain, from almost any class of material. Their use provides the quickest, cheapest and most efficient means of mechanical drying that has ever been devised.

Messrs. Thomas Broadbent and Sons, Limited, of Central Ironworks, Huddersfield, show centrifuges and hydro-extractors of which the characteristics may be judged from Figs. 1 and 2, which illustrate a 36-in. swan-neck motor-driven centrifuge. In this machine it will be observed that the system of suspension for the spindle ensures that the cage and shaft can take up a position suited to the condition of the running. The cage may be made of copper in cases where nothing will be used in it which will cause deterioration of the metal, but for many other cases Monel metal has been used with success. As the cages are subjected to considerable stresses encircling bands are provided to give additional strength. Great improvements have been effected since the introduction of these machines by the use of direct and indirect electric driving. In the example shown in Figs. 1 and 2 an electric motor is set on the bedplate between the two side frames, and its drive is taken through a centrifugal clutch. This is introduced to get over starting difficulties as heavy load conditions must be met at the instant the bowl begins to revolve. Within the clutch pulley there is a clutch system which only grips upon the inner face of the pulley when the speed of the motor

CENTRIFUGAL MACHINES AT THE BRITISH EMPIRE EXHIBITION.

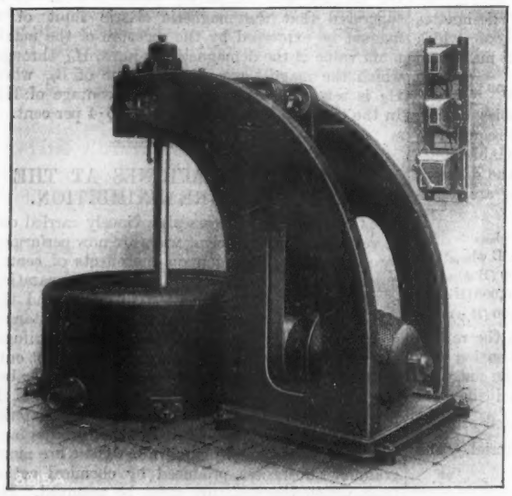
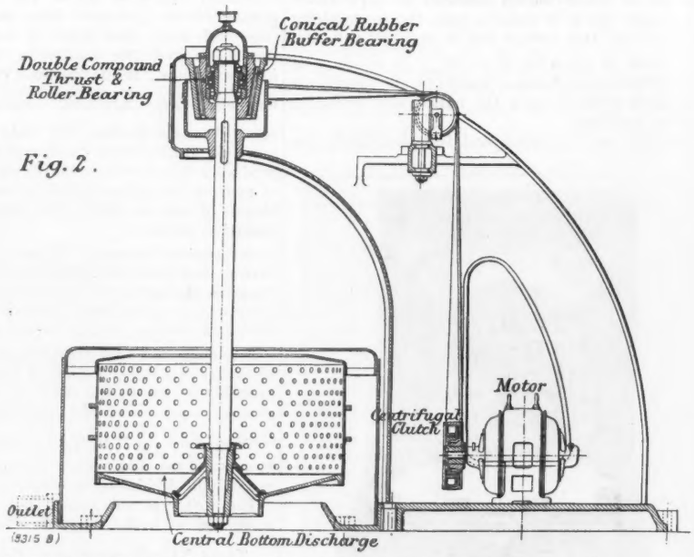


FIG. 1.



FIGS. 1 AND 2. SWAN-NECK TYPE OF HYDRO-EXTRACTOR; MESSRS. THOMAS BROADBENT AND SONS, LIMITED.

attains a certain high value. The clutch-moving system consists of four quadrant-shaped parts sitting freely in the spaces between the arms of a spider and the two covers. These moving parts are forced out by centrifugal action, and as they are faced with a lining a good grip is ensured in normal working, and slip only occurs when the loads are abnormal. The clutch is, therefore, entirely automatic and permits the electric motor to accelerate against full load torque, without the use of special switch-gear and with a small current consumption at starting. Besides acting to prevent starting difficulties, the clutch serves as an effective safety device in the event of overload, since it can limit the torque that can be transmitted. Should an overload be thrown on the motor the clutch slips and continues to do so until the load is reduced to the normal, when it will automatically meet the conditions again. Such clutches are indispensable when single phase or squirrel cage motors are used. The belt drive is continued from the centrifugal clutch over a pair of jockey pulleys to the one which is keyed to the main spindle.

Examples of hydro-extractors made by Messrs. Watson, Laidlaw and Co., Limited, of 98, Dundas-street (South), Glasgow, are shown in Fig. 3 annexed, and Figs. 4 to 7 on page 819. In Fig. 4 a large double unit is illustrated, while two single-units are shown in Fig. 5. In each case the frame is built up from rolled steel sections, and electric driving is used, the motor being erected on the top cross frame. The control switch for the motor and the brake lever are conveniently situated for easy operation. Simple covers made of wire and hinged at the back are provided for the protection of the operatives. The type of plant shown is extensively used in laundries and in dye works.

An automatic safety guard is fitted to the hydro-extractor shown in Figs. 6 and 7. This device, known as the "Kamlok," is arranged to prevent the starting of the machine until the safety cover is closed and also makes impossible the lifting of the cover until the cage has ceased to revolve. The belt-striking gear is so arranged that when the cover is open, it is not possible to move the belt over on to the fast pulley. In Fig. 6 the cover is closed, and therefore the end of the striking gear can be moved freely backward and forward without fouling the cover. Should the cover be open, however, as is shown in Fig. 7, where the edge of it is held up by the top of the safety lock, movement of the striking gear is only possible to a very limited extent and not to the degree necessary to make the running of the cage possible. To ensure that the

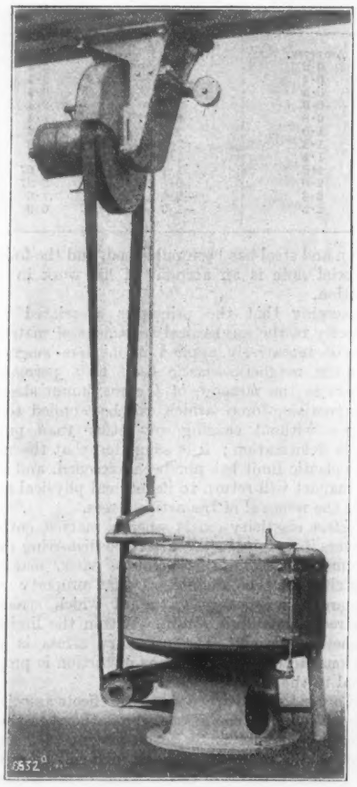


FIG. 3. KAMLOK SAFETY DEVICE; MESSRS. WATSON, LAIDLAW AND CO., LIMITED.

cover cannot be opened while the cage is running a cam is fitted on the underside of the basket and revolves with it. The roller of this cam is driven outwards, and the motion so obtained is carried through a bell crank and a side rod to the lever lock on the top. When the cage is running the lever lock is held in position so that the check on its underside catches on the edge of the cover. When the machine is stopped the cam roller moves in, and the lever lock is tilted to such an extent as to free the cover from engagement and make possible the movement necessary to open up completely. This is proportioned so that the tilt of the lever gives sufficient clearance as the machine stops. When the belt striker gear is overhead the arrangement shown in Fig. 7 is adopted. The cam system to prevent opening while the cage is running is the same as before, but the other part of the equipment is modified to suit the altered conditions. From the striker system a long rod gives connection to a bell crank one arm of which gives the movement to a substantial rod, of which the end can only be passed over the top of the cover when it is completely closed.

Messrs. Pott, Cassels and Williamson, of Motherwell, also make a variety of classes of centrifugal machinery, not only electrically driven but also making use of a water drive. Examples of the latter type are illustrated by Fig. 8 on page 820 and by Figs. 9 to 12 on Plate LXXXII. The water motor and the suspension system for the cage are shown in Fig. 8. The wheel to which the buckets are fitted is mounted in the top of a case which is supported on steel beams. Two jets are provided, of which the first is of large bore and is used in causing acceleration at starting, while the second is much smaller and is used alone after the proper speed has been attained. In starting, both nozzles are brought into service and the governor setting fixes the time at which the larger nozzle is cut out. Before explaining the action, however, attention may be called to the position of the governor, partly inside the hub of the water motor wheel, Fig. 8, and partly within a casting below, from which the drive is carried through links made of leather or other flexible material.

The centrifugal spindle is quite free to oscillate without causing any disturbance to the water wheel above. The interposition of the flexible links in the drive makes possible the easy separation of the motor and centrifugal whenever required. The ball bearing of the suspension system is kept running in oil continuously. A brake is provided on the rotating system to arrest the motion quickly when the machine must be stopped.

As has already been stated, both water jets are opened at starting and the large one is closed by the action of the governor when the proper speed is attained. As great demands for water are made in starting, Messrs. Pott, Cassels and Williamson have designed an interlocking gear to permit the starting of any machine only after the previous one is running at its full speed or to start half the machines after the other half have attained their proper speed. This is shown in Figs. 9

CENTRIFUGAL MACHINES AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. WATSON, LAIDLAW AND CO., LIMITED, ENGINEERS, GLASGOW.

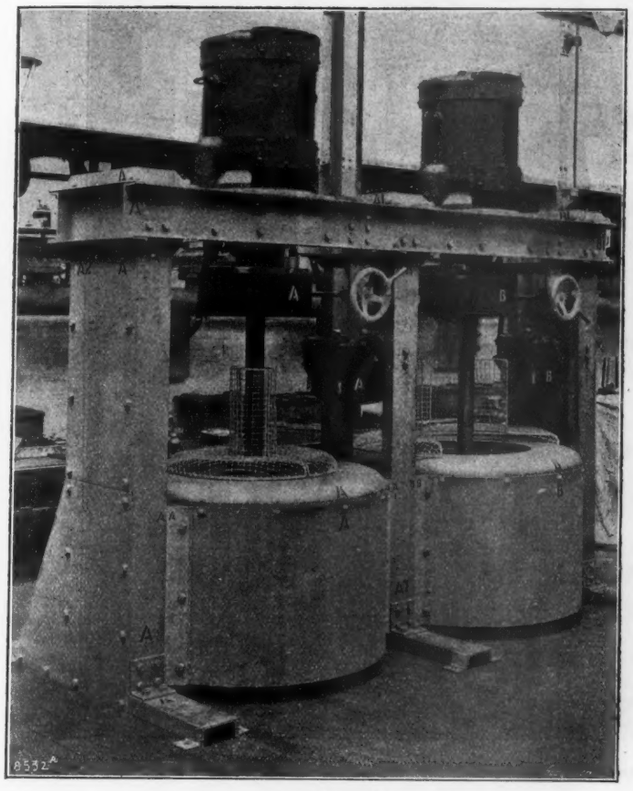


FIG. 4. SUSPENDED TYPE ELECTRICALLY-DRIVEN HYDRO-EXTRACTOR.

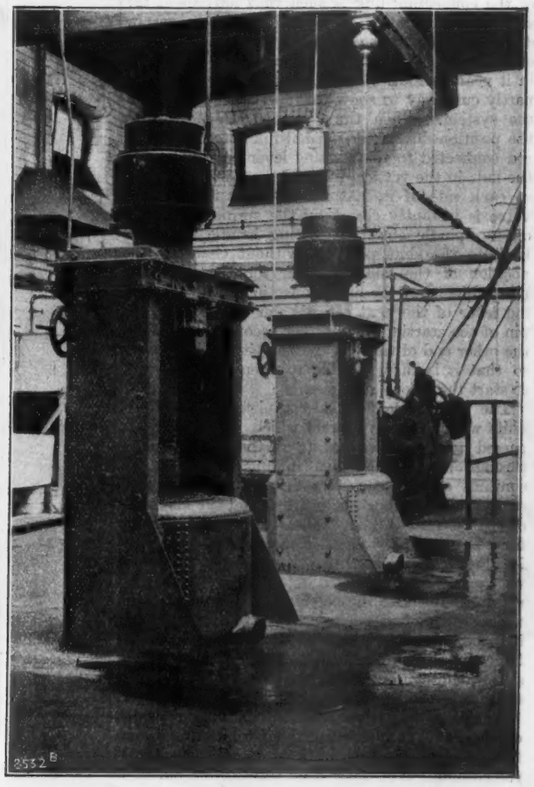


FIG. 5. TWO SINGLE UNIT HYDRO-EXTRACTORS.

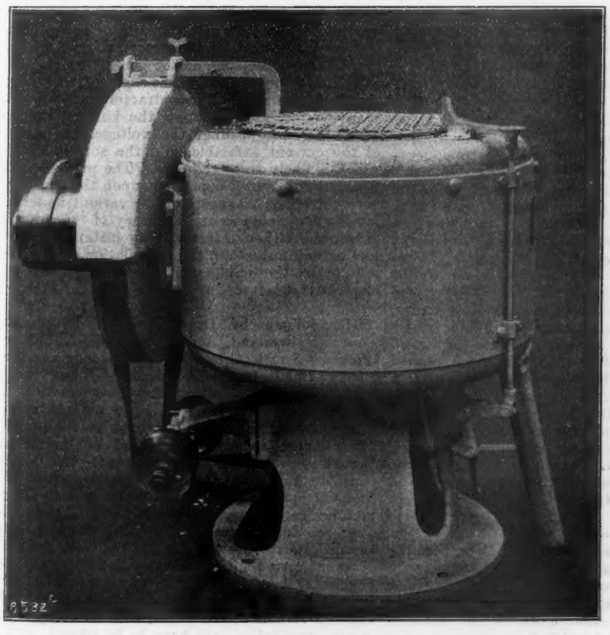


FIG. 6. KAMLOK SAFETY DEVICE IN RUNNING POSITION.

FIG. 7. SHOWING HOW THE SAFETY DEVICE PREVENTS STARTING IF THE COVER IS OPEN.

and 10, Plate LXXXII, and is also fitted to the machines illustrated in Figs. 11 and 12. The complete gear is shown on Fig. 9 set in position for the starting of the first unit and it will be noticed that while the lever for the large jet, the one to the left-hand side of the illustration, remains in the starting position, the position of the pin of the starting lever of the second machine in the slot of the connecting link is such that movement for starting is prevented. The motion of the governor sleeve is taken to the overhead lever on the other end of which is suspended a bar with a small hole in it near its foot. In Fig. 10 the rods have been partly cut away to show this and other features of the system. When the governor sleeve rises to the position due to the normal full speed the small rod connected to the starting lever passes through the hole in the vertical rod and those in the guides at each side of it. At that instant the starting valve is instantly closed by the spring held lever on its spindle and the starting handle is moved back to the shut position, without changing the position of the running lever for the same set, but pulling over the link connecting with the starting lever of the next set. When this is done the pin of the starting lever of the second set is left at the other end of the slot and thus it can be moved, so that it is then possible to open up the valve to start the second machine.

The arrangement of a complete plant of six units with a large vat from which the liquors are passed to the machines from the outlet valves through scoops is shown in Fig. 11. The vat contains a stirring system driven by gear wheels at the ends. The outlet pipes from the machines discharge into metal channels through which the fluid is carried away. A complete two-unit plant is illustrated in Fig. 12. The water pipe from which the power supply is obtained is situated high up at the back of the machine and the sugar from which the molasses is to be removed, or whatever is to be treated, is passed into the cages from the large circular pipe, which is also provided with a stirrer, through outlets at the foot, one of which is shown open in the illustration.

Another application of centrifugal force of which examples are to be seen at the exhibition is its use for the separation of dirt from lubricating oil and the elimination of water from transformer oil. The Vickcen separator made by British Separators, Limited, of Peckham, is a good example of this class of machine. In it the positions taken up in relation to the centre of rotation by different materials is used to separate solids from liquids and fluids of different densities. With these machines in use much time is saved in performing what was previously done by slow and inefficient processes, and the savings effected, not only in time but of the materials subjected to treatment, soon amount to the total cost of the installation. A full description with illustrations of the Vickcen separator was given recently in ENGINEERING (see vol. cxvi, page 309).

NOTES ON NEW BOOKS.

THE appearance of a second edition of a work usually implies the success of an earlier, and we hope that the work on "*Analytical Mechanics*," by Dr. E. H. Barton, F.R.S. (Longmans, Green and Company, London, 1924, price 21*s.* net) is no exception to the rule. Twelve years have elapsed since we reviewed the original treatise (February 2, 1912, p. 144), and though the fundamental truths of kinematics and statics do not alter, the method of presentation and the insistance on certain elemental propositions change with the views of teachers and examining boards. We imagine, however, that Dr. Barton has found little to alter, though he may have added much, more especially in the matter of examples, since examiners constantly find new conundrums to tax the ingenuity of candidates. The author is writing for those who have an elementary knowledge of the calculus and are more or less familiar with the ideas of mechanics, thus permitting the more elementary parts to be passed rapidly in review. The subjects treated are kinematics, in which the properties of vector quantities are early introduced, and kinetics, prefaced by an historical account of the physical conceptions underlying the theory. Here we expected to find an adequate appreciation of the views of Einstein and his school, but one short footnote contains the sole reference to the subject of relativity. Several chapters on statics follow, in which the motions of rigid bodies are discussed on the usual lines. The remaining sections on hydro-mechanics and elasticity are short in comparison with earlier sections as though the author had not allowed himself sufficient space. But this is not the reason, for these sections differ but little from those in the earlier edition. Many new examples selected from recent University examination papers have been added, and will make the volume very acceptable to students reading without assistance from tutors.

Aeronautics is one of the subjects which have developed on a strongly-scientific basis though, particularly during the war, daring and practice outstripped theory. Practical treatises on aircraft construction are still comparatively rare, and the theoretical element is apt to predominate. Dr. Ing. H. G. Bader, of Heidelberg, professes to have compiled his "*Flugzeugbaukunde; Einführung in die Flugtechnik*" (Construction of Aircraft; Introduction to Aeronautical Technics) [Berlin: Julius Springer; price 1·15 dols.] for "everybody who has the simplest conceptions of mechanics, velocity, acceleration, force, work, energy." But he really appeals to readers of somewhat more advanced knowledge, though Prandtl's theory is more alluded to than adhered to. The volume is based upon a course of lectures, delivered at the Technical High School, Stuttgart, and Dr. Bader speaks of Kutta, Lanchester, Joukowski and Prandtl in referring to the Göttinger theory without saying anything as to their shares in its development. Among the commendable illustrations of the volume of 121 pages are some of the metal wings of the Dornier Metallbauten Gesellschaft.

A good case can be made out for the claim that the most useful books for engineers are those which are constantly needed for reference, even though their contents may not be comparable in depth of erudition with the imposing scientific treatises on technical subjects. Every manufacturer and merchant engaged in the electrical business knows "*The 'Electrician'*

CENTRIFUGAL MACHINES; EMPIRE EXHIBITION.

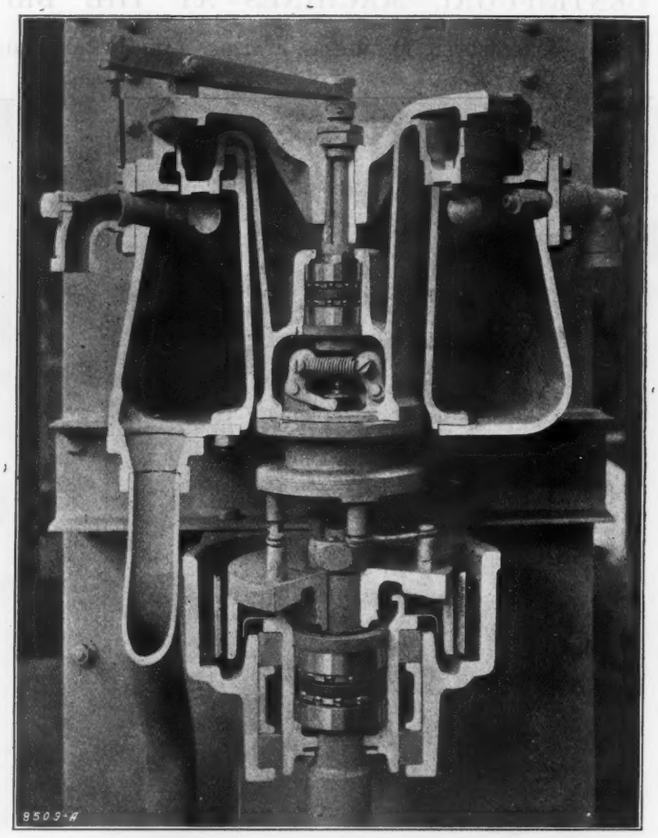


FIG. 8. WATER MOTOR, GOVERNOR AND SUSPENSION OF CENTRIFUGAL; MESSRS. POTT, CASSELS AND WILLIAMSON.

Annual Tables of Electricity Undertakings" (London: Benn Brothers, Limited; price 10*s.* net). The thirty-seventh edition, referring to the year 1924, has now reached us. The volume contains the leading facts concerning, we believe, every single electrical undertakings in the British Isles, and hundreds of others in the Empire and in foreign countries. The information comprises the population served, the nature of the supply, the equipment of the generating station, the names of the owners and of the engineer, and the prices charged for current. For contractors such information is invaluable, as they know the kind of plant with which they are dealing, the voltage, frequency, &c. of the current available, and the sort of apparatus which is likely to be required. The publishers of the book are, of course, dependent upon the courtesy and goodwill of the managers of the various undertakings for the completeness and accuracy of the information given, and although in some few instances one would like more information, the compilation as a whole is a tribute to the public spirit of the officials of the electrical industry.

The volume by Dr.sc.techn. E. Burgdorfer, of Thun, Switzerland, on "*Der Eingelenkbogen für massive Strassenbrücken*"—"One-hinge Arches for Heavy Road Bridges" (Berlin: Julius Springer; price 1·80 dollar) is essentially a mathematical monograph for the specialist. It begins with formulæ, and that treatment is adhered to even in the fourth and last chapter on economical and admissible spans, though two examples are worked out. Dr. Burgdorfer considers that the one-hinge bridge is, within certain limits of span and rise, the more superior to the fixed-arch bridge, the more the permanent load predominates over the load carried. The comparison is complicated, however, by the introduction into fixed arches of temporary joints and expansion devices. So far engineers have not shown any preference for the hinged arch, which is recommended, and Dr. Burgdorfer's volume of 160 pages, with its many sheets of graphs and tables, will have to be offered in a more popular garb to convert many bridge designers.

(To face page 820.)

CENTRIFUGAL MACHINES AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. POTT, CASSELS AND WILLIAMSON, ENGINEERS, MOTHERWELL.

(*For Description, see Page* 817.)

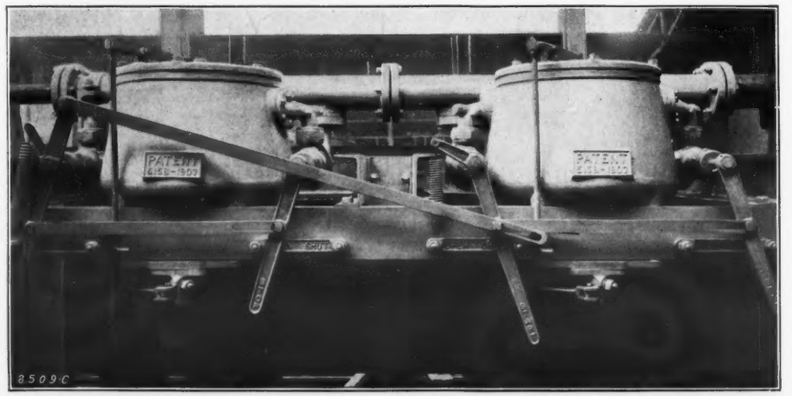


FIG. 9. INTERLOCKING GEAR.

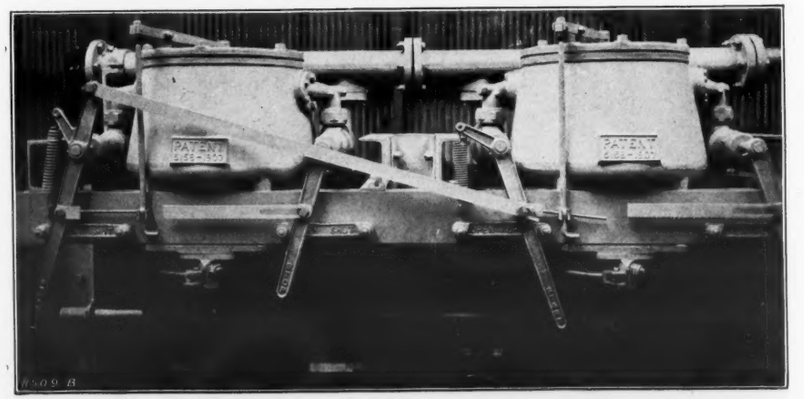


FIG. 10. VIEW WITH LINKS BROKEN TO SHOW TRIP SYSTEM.

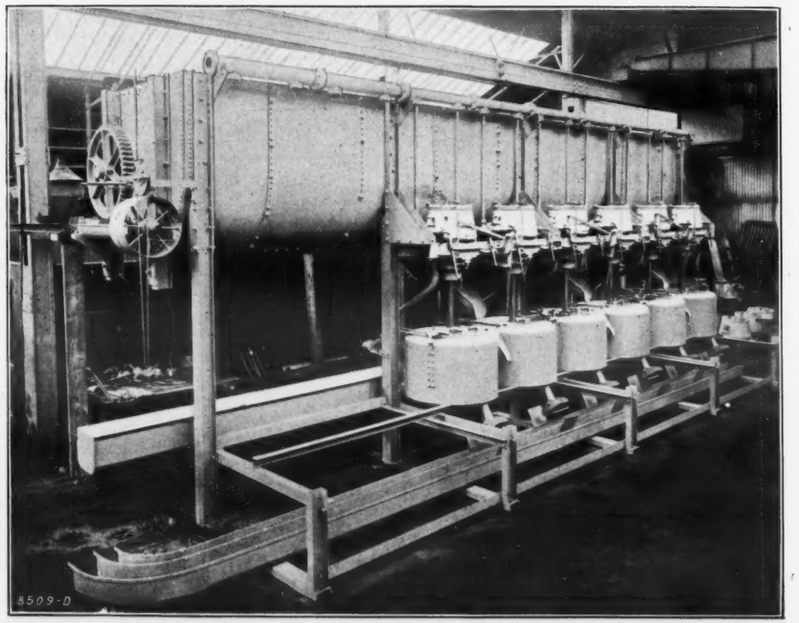


FIG. 11. LARGE CENTRIFUGAL PLANT FOR THE SEPARATION OF MOLASSES FROM SUGAR.

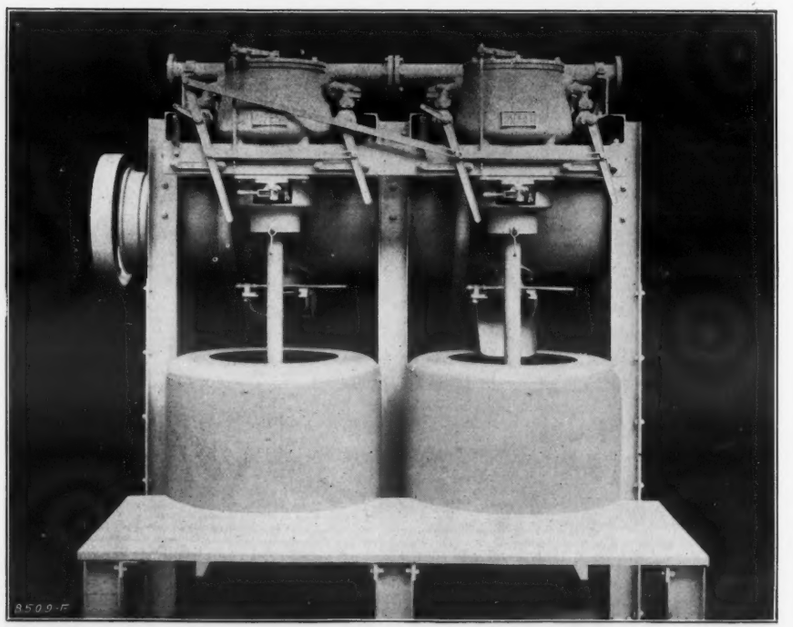


FIG. 12. A COMPLETE DOUBLE-UNIT CENTRIFUGAL PLANT WITH INTERLOCKING STARTING GEAR.

TURBINE-DRIVEN STEAMERS "PRINCIPESSA GIOVANNA" AND "PRINCIPESSA MARIA."

CONSTRUCTED BY MESSRS. FRANCO TOSI, SHIPBUILDERS AND ENGINEERS, LEGNANO AND TARANTO, ITALY.

(*For Description, see Page* 821.)

Fig. 1.

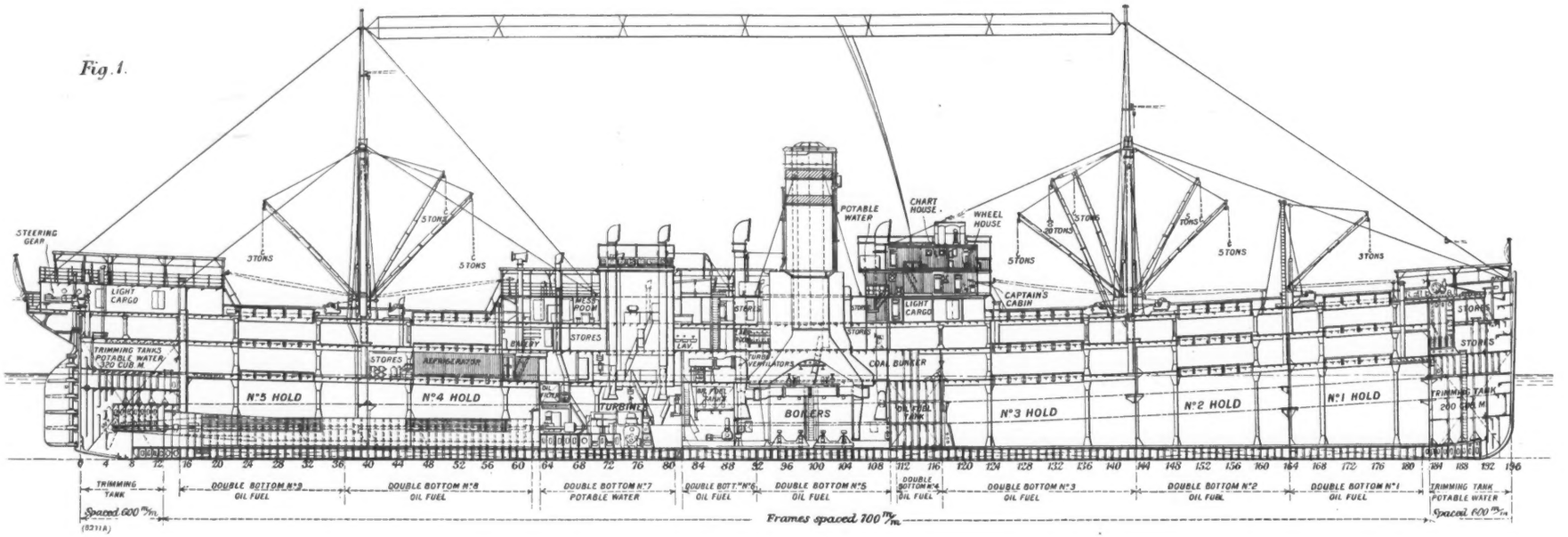


Fig. 2.

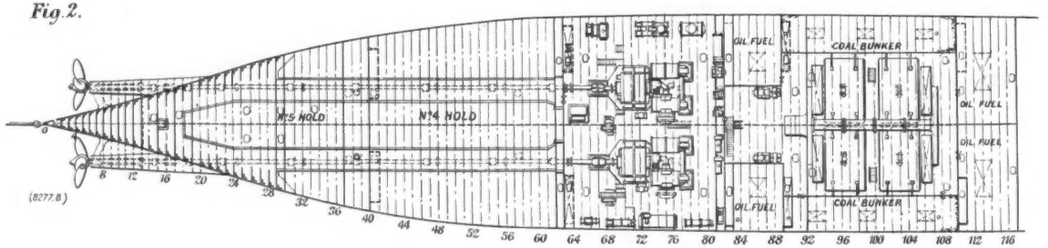


Fig. 3.

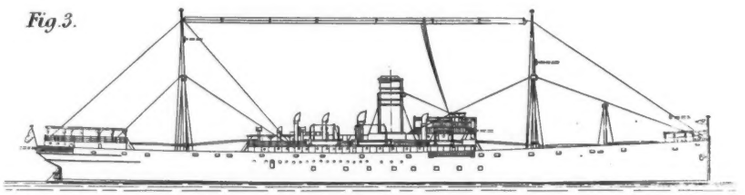
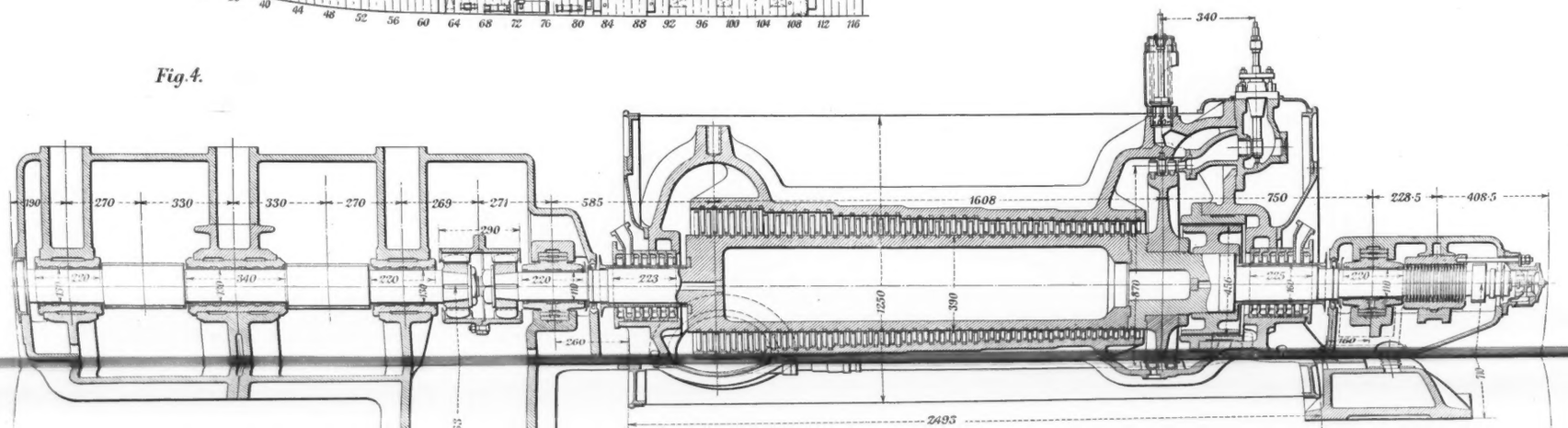


Fig. 4.



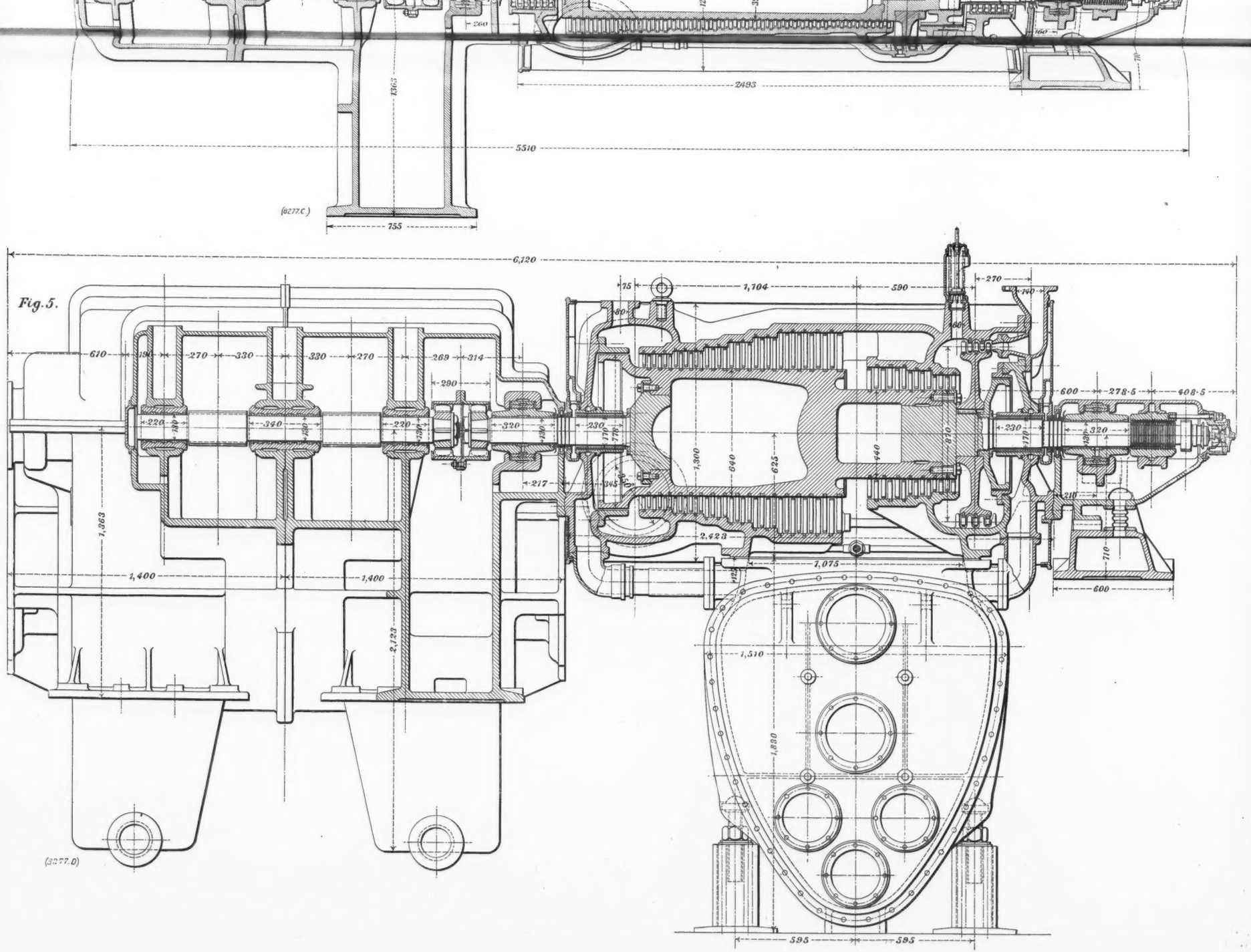


Fig. 5.
6,120
610
190
270
330
330
270
269
314
290
220
240
220
320
230
217
1,363
1,400
1,400
2,123
(8277.D)
75
1,104
580
270
140
60
60
600
278·5
408·5
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320
1,300
640
625
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2,423
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2493
260
710

AUXILIARY MACHINERY OF THE STEAMERS "PRINCIPESSA GIOVANNA" AND "PRINCIPESSA MARIA."

CONSTRUCTED BY MESSRS. FRANCO TOSI, SHIPBUILDERS AND ENGINEERS, LEGNANO AND TARANTO, ITALY.

(*For Description, see Page* 821.)

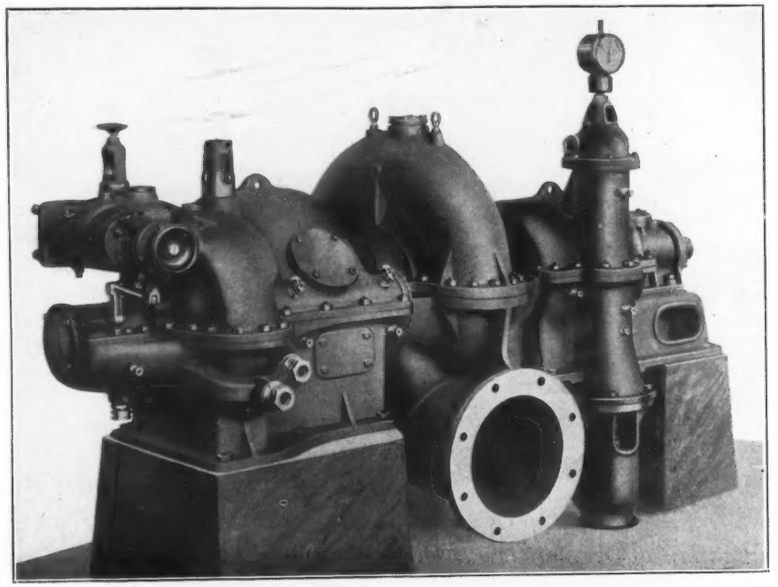


FIG. 6. AUXILIARY PUMP SET.

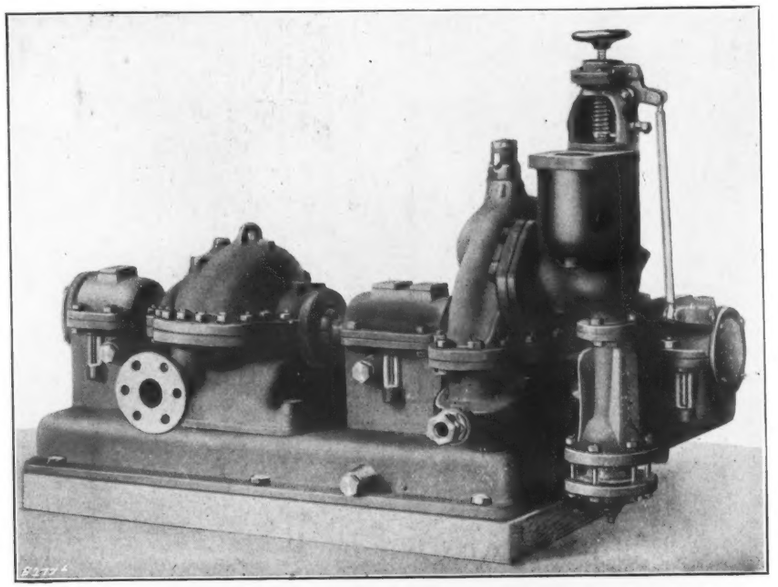


FIG. 7. BOILER FEED PUMP.

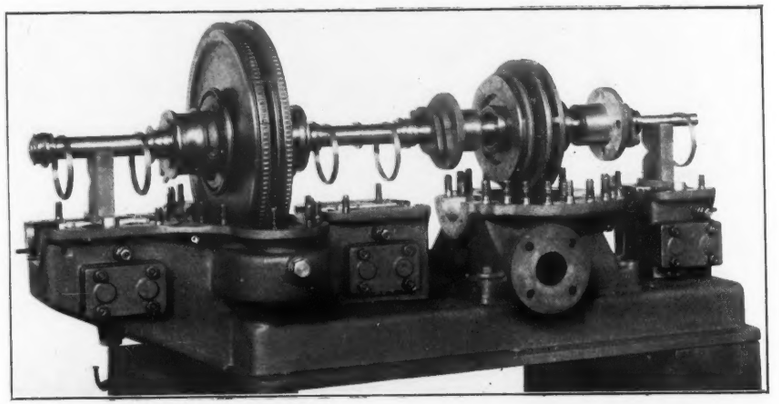


FIG. 8. BOILER FEED PUMP (WITH CASINGS REMOVED).

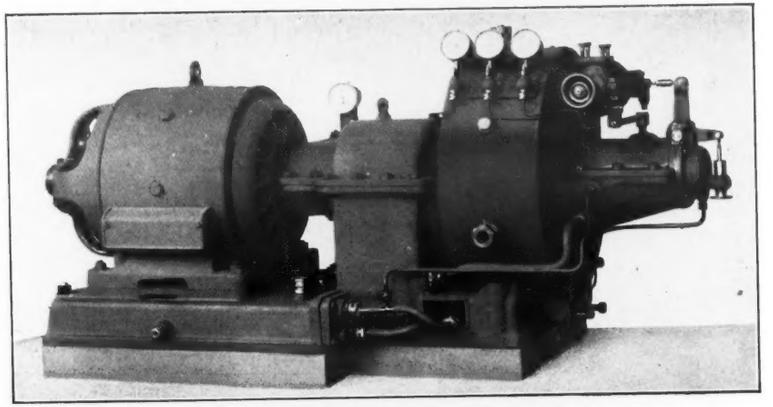


FIG. 9. 16-KW. 110-VOLT LIGHTING SET.

(*To face page* 821.)

THE TURBINE-DRIVEN STEAMERS "PRINCIPESSA GIOVANNA" AND "PRINCIPESSA MARIA."

IN one of his popular books entitled *The Sea*, F. Whymper states that a navy office was first formed in this country in the reign of Henry VIII (1509–47),

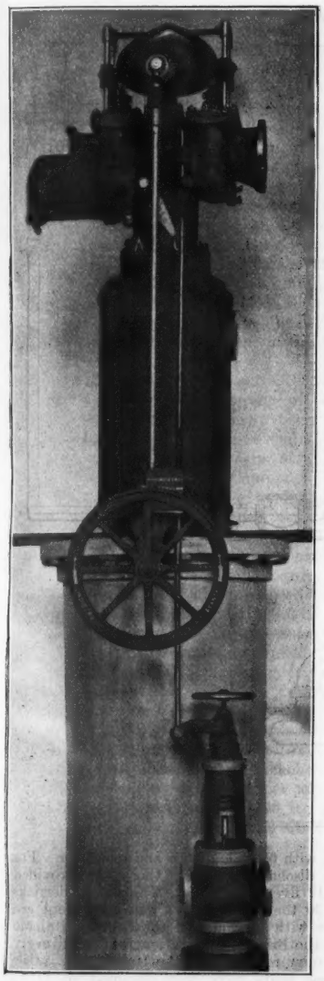


FIG. 10. DOUBLE-SLUICE STEAM VALVE.

when regular arsenals were put down at Portsmouth, Woolwich and Deptford. He adds that Italian shipwrights, at that time the most proficient in the world, were asked to come over to England, and under their guidance work was carried out so effectively that at the conclusion of Henry's reign the English navy consisted of 71 vessels, 30 of which were ships of respectable burden, aggregating 10,550 tons. During the four centuries which separate us from those early days in naval construction, Italy has remained to the fore in shipbuilding and shipping, passing gradually through the early period of wooden sailing vessels and reaching without intermission the present period of high-class engine-propelled steel ships, in the construction of which she has always shown an equally high proficiency, notwithstanding her comparatively meagre metallurgical resources.

We have dealt repeatedly with Italy's shipbuilding activity; in the present issue we illustrate two of her latest constructions, the cargo sister ships Principessa Giovanna and Principessa Maria, built last year at the Taranto shipyard belonging to Messrs. Franco Tosi, to the order of the Lloyd Sabaudo Company, Genoa. They are steel twin-screw ships of the awning-deck type, the propelling machinery being geared turbines supplied with steam from cylindrical boilers fitted for burning either coal or oil fuel. The principal dimensions and characteristic features of the ships are given in the table at the bottom of the next column.

The ships are shown in longitudinal section, plan and side elevation in Figs. 1 to 3 on Plate LXXXIII, the machinery being shown on the same plate, on Plate LXXXIV and on this page and pages 822 and 828.

The propelling machinery consists of two double-cylinder geared turbines, developing in the aggregate a grand total of 7,000 s.h.p., each set driving a propeller. Each 3,500 s.h.p. set consists of a high-pressure, a low-pressure turbine, with a double reduction gear which reduces the speed of the turbines from 2,600 revolutions to 100 revolutions for the turbine shaft.

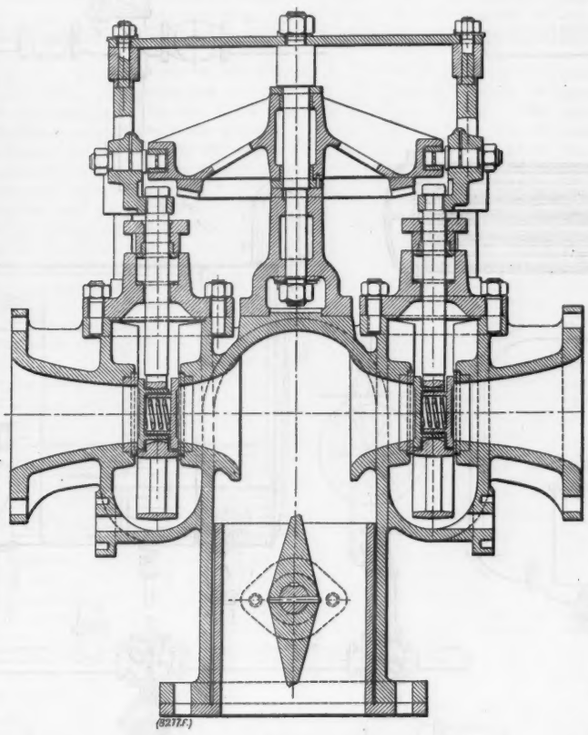


FIG. 11. DOUBLE-SLUICE STEAM VALVE.

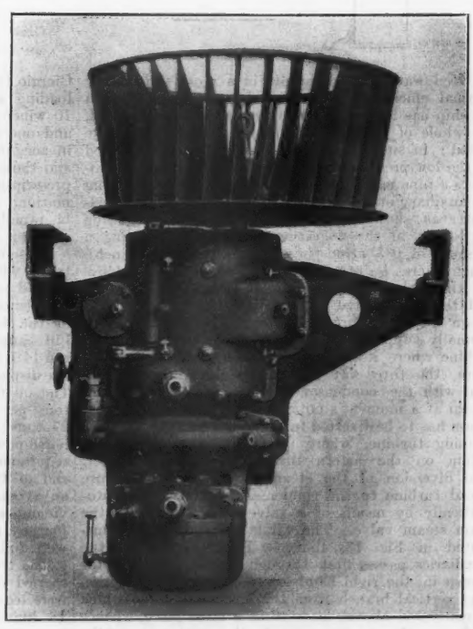


FIG. 12. TURBINE-DRIVEN FORCED DRAUGHT FAN.

A reverse turbine is incorporated in the low-pressure casing. Each turbine set is connected to a surface condenser. The circulating pump is gear-driven from a steam turbine, as also is the lubricating pump and a condensate pump. There is as reserve an auxiliary condensate pump also gear-driven from a steam turbine. Other equipment provided includes two ejectors, one being a stand-by, a boiler-feed centrifugal pump directly driven by a turbine, two geared-turbine driven fans for supplying the furnaces with forced draught, and four cylindrical return-tube boilers fitted with both steam superheaters and air pre-heaters.

The main steam turbines are illustrated in Figs. 4 and 5 on Plate LXXXIII, and in the views Figs. 14 and 15 on page 828. Each main steam turbine has a high-pressure and a low-pressure cylinder, the reverse turbine being incorporated in the low-pressure casing. Both forward and reverse turbines use a velocity-compounded wheel before the reaction blading. The high-pressure rotor is forged solid with its driving shaft, a built-up construction being used elsewhere. The gearing is of the double-reduction type, comprising two pinions coupled to the turbines, two intermediate countershafts and a main gear wheel keyed on the propeller shaft. The turbine being cross-compounded, the axial length of the pinions is only one-half that which would be required with both sections on the same shaft. Care has been taken to reduce to a minimum the torsional deformations of the pinions, thus ensuring a continuous contact of the teeth at all speeds. We may here state that the Tosi works have already built steam turbines for a total of over 1,600,000 h.p., both for land and sea service.

The condenser is of the triangular type, having an abundant cooling surface and so designed as to practically eliminate all resistance to the steam flow during its passage through the nest of tubes; it is provided with adequate means for cooling the non-condensable gases. The condenser casing is fitted with two steam ejectors for air extraction and two condensate pumps, there being no reciprocating air pumps which usually take up a large amount of room.

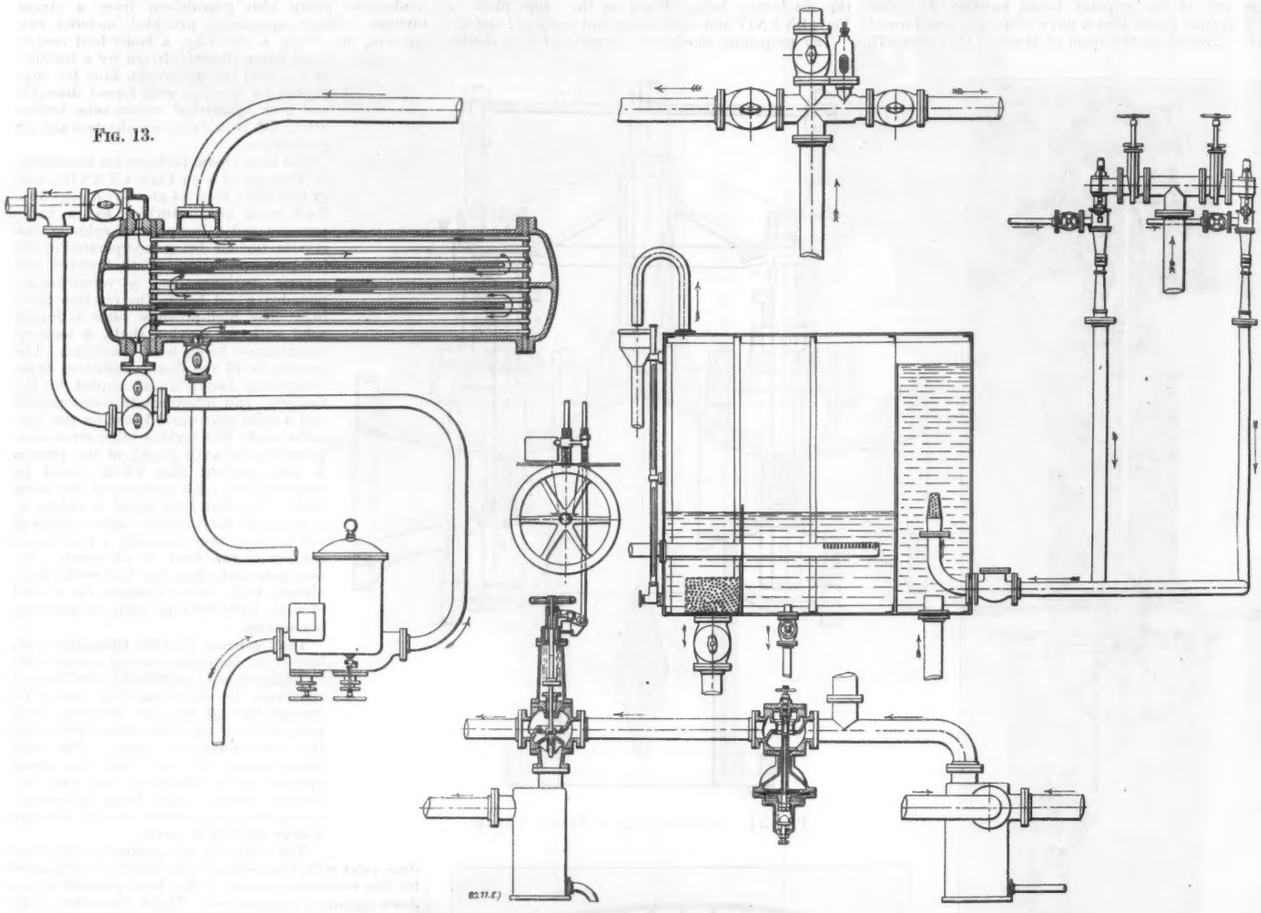
The ordinary air pumps having been done away with, thus reducing the number of auxiliaries for the condensing plant, it has been possible to put down one single auxiliary set. This is illustrated in the view, Fig. 6, Plate LXXXIV. This set consists of a 50- to 60-h.p. turbine running at a speed of 5,500 revolutions, which drives by gearing a centrifugal circulating pump

	Metres.	ft.	in.
Length overall	140·125 =	460	0
Length between perpendiculars	134·600 =	441	0
Extreme breadth	18·000 =	59	0
Depth from keel to upper deck beam	12·300 =	40	4
Depth from keel to main deck beam	9·800 =	32	2
Depth from keel to second deck beam	6·800 =	22	4
Height from upper deck to boat deck	2·500 =	8	2
Height of boat-deck house	2·400 =	7	10
Height of wheel-house	2·200 =	7	2
Height between main deck and upper deck	2·500 =	8	2
Height between second deck and main deck	3·000 =	9	10
Mean draught, summer	8·435 =	27	8
Corresponding displacement	15,600 m. tons.		
	Metres.	ft.	in.
Mean draught, winter	8·270 =	27	1
	M. tons.		
Corresponding displacement	15,250		
Gross registered tonnage	8,389·120		
Net registered tonnage	5,098·440		
Deadweight carrying capacity, summer	10,500		
Deadweight carrying capacity, winter	10,000		
Capacity of double bottoms	1,570		
Capacity of water ballast tanks	520		
Capacity of oil fuel tanks	810		
Capacity of potable water tanks	210		
Capacity of coal bunkers	2,050		
	Cub. m.	Cub. ft.	
Cargo space outside frames	12,900	455,590	
Cargo space within frames	12,200	430,860	
Speed in service	14 knots.		
Speed at trials	15 knots.		

AUXILIARIES OF SS. "PRINCIPESSA GIOVANNA" AND "PRINCIPESSA MARIA."

CONSTRUCTED BY MESSRS. FRANCO TOSI, ENGINEERS AND SHIPBUILDERS, LEGNANO AND TARANTO, ITALY.

FIG. 13.



for the condenser and an oil pump, both at a speed of 500 revolutions. A vertical centrifugal pump for withdrawing the condensate is driven through helical gearing at about 2,000 r.p.m. by a small steam turbine. A second pump for withdrawing the condensate, also driven by a steam turbine, is provided as a stand-by; one of the circulating pumps can also be used for emptying the water-ballast tanks.

The four boilers, as above stated, are of the cylindrical return-tube type, fitted with superheaters. The total heating surface is 1,416 sq. m. (15,200 sq. ft.), the grate area being 28·70 sq. m. (307·85 sq. ft.); the effective pressure is 12·7 atm. (180 lb. per square inch). The boilers are provided with soot blowers and all modern fittings, air pre-heaters, &c. They are fitted for oil or coal burning. Forced draught is obtained by means of Tosi turbo-fans. There are two centrifugal feed pumps (Figs. 7 and 8, Plate LXXXIV), one of which is sufficient for the normal service, the other being a stand-by. Each is directly driven at 6,000 revolutions by a turbine; the pump impeller and diffuser are throughout of brass, and a special patent automatic governor is provided. Steam is supplied to the main turbines by a double sluice-valve, shown in Figs. 10 and 11, on page 821; it is easily operated by a hand wheel for either forward running or running astern, one valve being opened when the other is closed. A throttle valve is also provided on the steam pipe. The steam supply is controlled by an oil relay; the oil pressure is regulated by a governor fitted to the turbine shaft, so that should the turbine speed exceed a given limit, the steam supply to the turbine is automatically throttled.

Fig. 9, on Plate LXXXIV, is a view of one of the turbine-driven 16-kw. 110-volt electric lighting sets; whilst Fig. 12, on page 821, shows one of the turbine-driven forced draught fans.

The fact that the auxiliary pumps are all driven by high-speed turbines has the advantage of eliminating oil from the feed and checking air leakage, besides being economical of steam. In normal running the whole of the exhaust steam is utilised for heating the feed water, which results in a most satisfactory thermal efficiency for the whole equipment. When the ship has to run for some time at a reduced speed, the whole of this steam cannot be utilised as above stated; in such a case the excess steam is diverted to the low-pressure turbine. The arrangement comprises a pipe which collects the steam exhausted from the auxiliary machinery and is connected to the feed-heater as shown above, a relief valve preventing the steam in the collecting pipe from exceeding a pressure of 0·3 atmosphere (5 lb. per square inch). When there is insufficient feed-water to condense all the exhaust steam, the pressure tends to rise and the relief valve automatically allows the excess steam to flow through a three-way valve which normally supplies it to the inlet of the low-pressure turbine where it expands producing work. Furthermore, the three-way valve establishes communication with the condenser when it is desired to run astern at a moment's notice, in which case the excess steam has to be diverted from the low-pressure forward running turbine, where it would have a braking action on the astern turbine, to the condenser. The diversion of the steam from the low-pressure ahead turbine to the condenser is carried out automatically by means of a valve interlocked with the main steam valve. The whole arrangement is illustrated in Fig. 13, above. The steam from the auxiliaries passes first through the water separator shown in the right-hand lower corner of the figure. The vertical branch from the horizontal pipe (which is continued above) leads it to a cross-piece, whence it flows either to the right to the condenser, to the left to the feed-heater, or upwards to the atmosphere. If all these exits are closed the steam passes from the separator through the oil-controlled throttle valve, then normally downwards through the adjacent stop-valve, through another separator to the low-pressure turbine. The closing of this stop-valve by the operation of the main stop-valve allows the steam to pass straight through to the condenser.

The steering gear is electro-hydraulic, of the San Giorgio type, with tell-tale device and telemotor. For loading and discharging cargo, there are provided 10 winches, 12 five-ton derricks, 4 three-ton derricks and one of 20 tons. The ships and equipment are in accordance with the rules of the Registro Italiano and those of the British Corporation, and fulfil every prescription now required of the Italian mercantile marine. These boats have been designed so as to be rapidly transformed into passenger and emigrant-carrying ships.

As soon as the Principessa Giovanna had run her trials, which proved satisfactory in every respect, she started on August 23 last from the Tosi Taranto yard for Genoa, whence she entered the Australian Line of the Lloyd Sabaudo on September 4, carrying a full cargo. At the trials on August 21 she easily ran 14·5 knots and attained 14·9 knots as a maximum, her displacement at the time being 7,760 metrical tons. The oil fuel consumption during the trials was 25·6 tons per 12 hours, less than the contract figure of 27 tons; the geared turbines developed 6,511 shaft horse-power, which was in excess of the contract requirements. The ship left Australia towards the end of December with a full cargo, and maintained an average speed of 13·2 knots. She encountered a violent storm in the Mediterranean on this return journey, during which her excellent navigating qualities were fully exhibited.

The trials of the sister ship Principessa Maria were carried out at Taranto on November 18, 1923, and were equally satisfactory. Her average speed was 15 knots; the power developed was 7,200 shaft horse-power; the oil-fuel consumption was comparable with that of the former ship. The sister ship is on the Lloyd Sabaudo Company's same line, and left for her maiden voyage to Australia in December last.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.—This Institute has published a list of books recommended to students. Copies of the list may be obtained free on application at the Institute, 9, Conduit-street, Hanover-square, W. 1.

THE NATIONAL PHYSICAL LABORATORY.

THE annual inspection of the National Physical Laboratory brought last Tuesday an unusually large contingent of visitors from the Dominions to Teddington. The visitors were, after the meeting of the General Board, received by Sir Charles Sherrington, as President of the Royal Society *ex officio* Chairman of the Board; Sir Arthur Schuster, Chairman of the Executive Committee; and Sir Joseph E. Petavel, Director of the Laboratory. This year's Report* covers the period October, 1922, to December, 1923, and outlines the work proposed for 1924; most of the manifold demonstrations of last Tuesday illustrated recent advance. There have been no additions to the buildings, but the work has grown steadily, owing mainly to the requirements of Government departments and research associations, and the staff has had to be increased, in spite of a slight falling off in commercial testing. On questions of general research the Executive has had, since the end of 1922, the advice of a Research Committee, consisting of Sir J. J. Thomson, Sir William Bragg and Sir Ernest Rutherford. It will be difficult to do justice to the valuable work done in the Laboratory in the space at our disposal.

Engineering Department.—Dr. T. Stanton's experiments on the damping of the rocking shafts of heavy pendulums have been continued. The efficiencies of helical and chain gears which have been determined by means of a machine supplied by the Power Plant Company of West Drayton, are surprisingly high, exceeding 99 per cent. in some cases and 98 per cent. even when the parts were out of gear by 0·04 in. The new big-end bearing testing machine, designed and constructed by Messrs. Ricardo, can run up to 4,000 r.p.m. Load and speed are gradually increased until the bearing fails and speed-load factors (product of the pressure on the projected area of the bearing multiplied by the rubbing speed) of 30,000 lb. per sq. in. ft. per sec. have been obtained. The machine for the cutting-tool research now in hand was also a novel exhibit. One point brought out is that certain materials have a well-defined minimum of cutting resistance at a certain speed; with nickel-chrome steel that resistance was, at 20 ft. per minute, only 64 per cent. of what it was at 50 ft. per minute and higher speeds, but in mild steel this effect was barely perceptible. Having finished his comparative tests on tramcars and their bearings, Mr. Hyde has fitted up a motor-car for recording the vibrations of the fore and aft springs while on road.

With respect to general fatigue phenomena the experiment of the Metallurgy Department appear to show that slip bands occur, even at safe ranges of stress and are not a criterion of ultimate failure; and that the conditions tending to cracking cannot be studied with crystalline aggregates, owing to the various orientations involved, but require the examination, by various methods, of single crystals. When in shafts provided with keys torque was transmitted through the key, the crack started at the junction of the bottom and side of the keyway, final fracture ensuing in the circumferential direction. Under repeated torsional stresses shaft fractures occur in the direction either of the planes of principal stress or of maximum shear stress. The spiral fracture had been considered to be typical of hard steels, the axial (or circumferential) fracture of soft steel. But according to an unpublished research of Mr. R. V. Southwell, Superintendent of the Aerodynamics Department, the axial fracture would be normal for sound material, whilst a small flaw or a small hole drilled into the specimen would much increase the principal stress and lead to helicoidal cracking. Other experiments confirm this hypothesis. A test based upon the crippling load, instead of the "proof" test now in use for the acceptance of structural steel strip used for aircraft has also been devised. The proof test specifies a certain minimum deformation resulting from the application of a proof tensile stress, but the validity of the criterion has been questioned. In the new test the strip is partly subdivided into three strips by rows of perforated holes; the strip is then put into a machine which pulls the two outer portions in the one direction, and the inner strip in the opposite direction; buckling is then produced in the intermediate portions, and this buckling corresponds to the stress condition to which the strip would be exposed on aircraft.

One of the objects of the investigation of the properties of materials at temperatures up to 700 deg. C. is the phenomenon of creep. The creep (or gradual flow) depends on the rate of loading and may set in at much lower temperature than had been expected, even below 300 deg. C. The test piece to which a high temperature extensometer is fitted is placed in a cylindrical electric furnace, 11 in. high, 8 in. diameter, which is sometimes made up of two halves hinged together. These tests, so far applied to Armco iron and electrolytic iron, are continued, in a battery of furnaces, for weeks until a test piece fails. Impact tests conducted at low temperatures (+ 17·5, − 38·5, — 80 deg. C.), on the other hand, show that mild steel loses a good deal of its strength at low temperatures, to which the hardened and tempered nickel-chrome steels are much less susceptible. The cylinders for liquefiable gases are tested at temperatures up to 85 deg. C. and pressures of 228 atmospheres. Some new portable duralumin cylinders contain 14 cub. ft. of gas (oxygen) at 120 atmospheres, and weigh, without valve, only 8¼ lb. The researches on the effect of temperature and pressure on the production of detonation in internal combustion engines, conducted in apparatus previously described, have been continued with air-petrol mixtures, and further with hexane, methane and benzene. One of the particular points studied is whether the increase of the severity of the "knock" observed with increasing petrol proportions is due to the deposition of carbon; the supposition has not been confirmed.

We should also mention an exhibit of rust-preventing coatings on parts of steel to be stored or to be exposed to salt spray, warm water, &c. Grease-coated specimens seem to keep better than those coated with drying enamels, resin or bitumen; the latter are apt to allow corrosion to start under cracks and to proceed in unsuspected spots. Grease deposited from readily-vaporised solutions will adhere well, but such solvents are not easily found, and the skill of the operator is as important as it is in welding. Lanoline has given good results.

Aerodynamics Department.—The keynote of the work of this department is fundamental and continuous research tending towards radical development rather than towards immediate improvement of practical design. For that reason the study of the air round an aerofoil on the Lanchester-Prandtl theory claims first attention. Experimentally that means to determine how far the actual distribution of velocity round an aerofoil agrees with the hydrodynamical distribution of an inviscid fluid when the circulation is given a value such as would in theory be accompanied by the lift actually measured, and measurements of the vortex sheet and tip vortices behind an aerofoil. An aerofoil can effectively be given the theoretical infinite length by being carried right up to the walls of the wind tunnel. In order to solve the hydrodynamical equations in the case of an aerofoil of given shape moving in air constrained by the tunnel walls, recourse has been had to the fact that the equations are identical with those governing the potential in an electrostatic field containing a conductor, the stream lines corresponding to the equipotential lines. The aerofoil to be studied is placed vertically in the water of a rectangular tank, two opposite sides of which are lined with sheet aluminium, the electrodes of a small alternating-current generator. We described last year how the equipotential lines are determined with the aid of exploring electrodes and how circulation can be introduced by giving the model a definite potential. The stream lines round a flat plate have in this way been found to agree closely with the calculations and the exploration is being continued for aerofoils of finite aspect ratio, also by making the tank bottom sloping.

These observations are checked by very careful measurements on the same aerofoil in two wind tunnels (the 4-ft. and the 7-ft.), with special regard to the correction due to the effects of the walls. The special study of tapered foils has further supported Prandtl's theory. In another line of research use is again being made of the whirling arm to investigate the forces acting upon a spheroid. One of the crucial experiments of these researches was demonstrated last Tuesday. Comparative experiments between flow in air and in water have so far been vitiated by the fact that the technique of the wind tunnel differs from that of the water tank. The apparatus has therefore been arranged in such a manner that it can be mounted in the tunnel and then bodily be shifted to the tank and attached to the carriage. By testing the model in air and water at the same Reynolds number. values really comparable will for the first time be obtained; any discrepancies would be due to turbulence. The model is a cigar-shaped body mounted horizontally in the tunnel; a steel rod about 2 ft. long slides longitudinally in the body and bears with its inner end against the levers connecting the model with the balance on the top of the tunnel. The outer end of the rod carries a "bomb," a wooden spheroid which represents the first shape to be tested. The wind presses this bomb and the rod into the body; as the levers are encased in tubes, the bomb is the only movable part exposed to the wind forces. Visitors noticed that the rear honeycombs in the 7-ft. tunnels have been removed; they had originally been introduced to steady the air flow, had then been widened out, and have now been taken away, without prejudicial effect to steadiness, in order to increase the maximum air speed available, now 110 ft. per second.

Of other important work we notice the series of experiments made with a complete model of a Bristol fighter, without or with its air screw, which is driven by the three-phase motor described last year. Tandem aerofoils do not appear to offer particular advantages. Improvement of the lateral control of planes at low speeds by means of air flow through slots in the wings and flaps has been found quite feasible in various ways. In order to ensure the safe descent of a helicopter after engine failure, a resistance approximately equal to that of a flat plate having an area equal to the disc area of the screw should be available.

The William Froude National Tank.—Since December the Tank Committee has lost three distinguished members, Mr. R. E. Froude and Dr. W. H. Maw, through death, and Colonel Crompton, through retirement; Messrs. H. G. Williams, Sir R. T. Glazebrook and Professor Horace Lamb have been appointed in their places. A visit paid by the Chamber of Shipping to the Tank has helped the research fund to the extent of 1,000*l*. Recognition of the industrial value of the work is evidenced by the recovery in private work from the depression of the last years. There were in 1923, 56 models tested for resistance and hull form, against 35 and 38 in 1922 and 1921, and of these 22 (against 4 last year) were also tested with screw propellers. To exemplify the importance of this work without losing time—the Tank is fully booked up—Mr. Baker last Tuesday gave his chief demonstration a novel form. He enabled visitors to watch how a model is tested in loaded condition, fully submerged with propeller behind, and that work was carried on as in ordinary practice, from morning till evening.

Work on the influence of waves on resistance is being continued with special regard to fullness of form. In connection with the investigation of manœuvring, and particularly the study of the influence of shoal water on steering, Mr. Baker last autumn paid a long visit to the Suez Canal. The streamline research, mentioned last year, of the flow past a model immersed to a depth of 5 ft., has been extended, and friction experiments are now made on planks 28 ft. and 32 ft. in length. An aeronautical investigation concerned the comparative advantages of longitudinal and transverse

* The National Physical Laboratory Report, October, 1922 to December 1923 inclusive. Published by H.M. Stationery Office for the Department of Scientific and Industrial Research. Price 13*s.* 6*d.* net.

steps in the planing bottom of a hull. As was expected, longitudinal steps were not found to give the cleanness of running and stability obtainable by a main and a small transverse step. But the corrugations of metal bottoms, required when flat bottoms would be too weak, called for further study, which is also completed now. As regards steam-trial analysis, assistance is being given by Messrs. Souter and by the North Eastern Engineering Company on full-scale experiments. In these cases, as well as in trials of a ship of Messrs. Furness, Withy and Co., members of the Tank Staff have been able to attend the trials; in other cases, where data are furnished for analysis, full attention is not always paid to essential features.

(To be continued.)

THE INTERNATIONAL FOUNDRY TRADES EXHIBITION AT BIRMINGHAM.

THE second exhibition of foundry plant, pattern-making and the materials used in the industry, was opened at the Bingley Hall, Birmingham, on Thursday, June 19, by Mr. R. O. Patterson, President of the Institution of British Foundrymen. This exhibition, like the successful one of 1922, was organised by the Birmingham Chamber of Commerce, in association with the Institution of British Foundrymen and the Cast Iron Research Association, and they must be commended for their enterprise and congratulated on the thorough way in which they have carried out the organisation of what must be regarded as a very valuable contribution to the efforts made to show how costs of production can be reduced and progress made possible in the foundry trades. In addition to the display of modern equipment, many other means of improving the industry have been used by the promoters, who have organised a series of lectures on foundry practice, and have arranged competitions in pattern-making, core-making and moulding in connection with the exhibition. These competitions are open to all foundry employees, ex-service trainees and technical school students in Great Britain. The exhibits cover the entire range of foundry work, from the raw materials employed, the cupolas and tools necessary to their use in the industry, to the finished products. At a time when every endeavour is being made to standardise the engineering products of a firm to ensure cheap production it is natural that great prominence should be given to moulding machines.

Messrs. Macnab and Co., of Eagle-street, Southampton-row, London, show the Tabor combination moulding machine. In this jarring is used, and the moulding box is rolled over from the table by power and the pattern is then drawn. The machine is illustrated in Figs. 1 and 2 by two views at different stages in the operations. Everything, except the filling of the sand into the box and the removal of the box after the mould is completed is performed by purely mechanical means. When in use the pattern board is placed upon the jarring table at the right-hand side of the machine and is held in place by two dowel pins. The box is placed upon it and the sand filled in around the pattern. Jar ramming follows, and is carried out without shock to the rest of the machine. This stage in the operations takes only about 30 seconds for its complete accomplishment. Once the ramming is completed and the bottom board is put on and clamped in place, the operation of a valve starts the roll-over action. The roll-over frame rises, picks up the entire load from the jarring table, automatically locking the pattern plate in position at the time. Then the moulding box is turned over and deposited on the levelling table. Fig. 1 shows the turning-over action in progress. The wedges of the levelling device on this side of the machine are then put into action through their levers, and they bed the box in such a position as ensures a perfectly clean draw out of the pattern. For this the clamps are removed and an air cylinder is used to force the pattern board upwards clear of the mould. When it has been completely removed, the roll-over frame returns to its original position, placing the pattern plate on the jarring table and leaving it available to receive the next box. At this stage the machine is shown in Fig. 2, the mould being shown on the one side of the machine ready for removal while the pattern is at the other, free for further use. The complete cycle of operations does not take more than three minutes.

Two features which contribute to the successful working of the machine are the jarring valve and the vibrator. The former ensures a rapid succession of blows, but is fitted on the machine quite clear of falling sand and therefore free from injury, while it is easily accessible for lubrication. The vibrator

COMBINATION MOULDING MACHINE AT THE FOUNDRY EXHIBITION.

CONSTRUCTED BY MESSRS. MACNAB AND CO., LONDON.

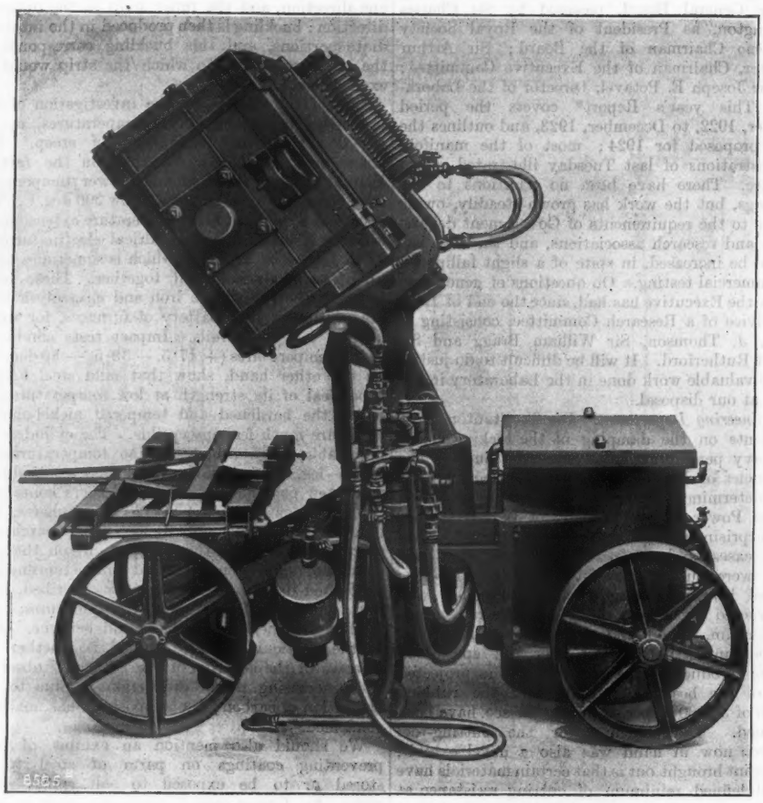


FIG. 1. ROLL-OVER ACTION IN PROGRESS.

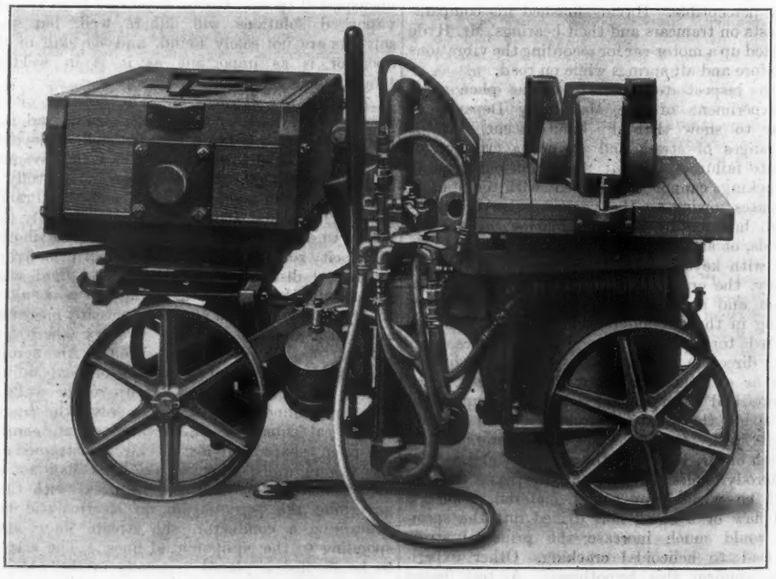


FIG. 2.—MOULD COMPLETED AND PATTERN BOARD REPLACED.

SANDSLINGER MOULDING MACHINE AT THE FOUNDRY EXHIBITION.

CONSTRUCTED BY FOUNDRY PLANT AND MACHINERY, LIMITED, GLASGOW.

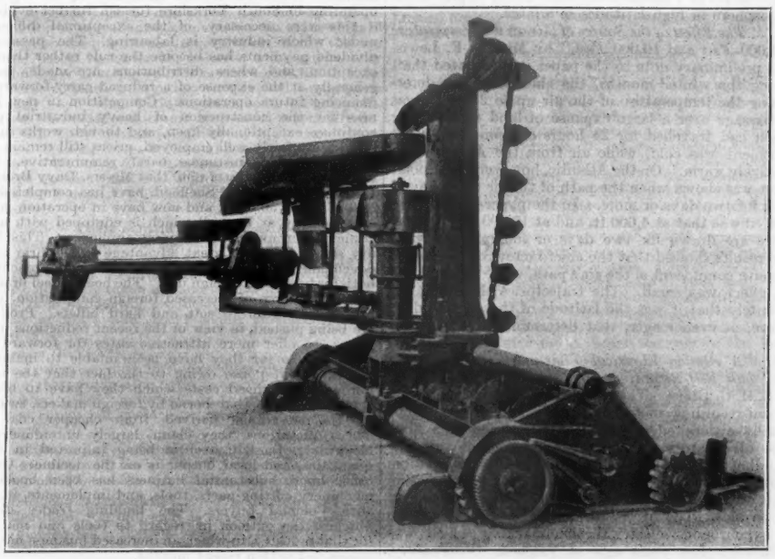


FIG. 3. TRACTOR TYPE OF BEARDSLEY-PIPER SANDSLINGER.

comes into action when the pattern is being drawn. It strikes blows at the rate of 30,000 per minute and not only assists in the drawing of the pattern, but ensures uniformity in the size of castings produced. No appreciable enlargement of the mould is caused by it, but it does serve to overcome the frictional resistance between the sand and the pattern.

With a view to eliminating the labour and time entailed in ramming, the Beardsley-Piper Sandslinger was introduced by Foundry Plant and Machinery, Limited, of 100, Wellington-street, Glasgow. This is a machine from which sand is thrown with such force into a moulding box that no ramming, taken in the ordinary sense, is required. One great disadvantage of ordinary moulding machines is that they have a limited capacity in that only patterns up to certain sizes can be dealt with. The sandslinger, in contrast to this, can be used in dealing with any size of work. The machines are built in four types: stationary, tractor, portable, and locomotive.

The illustration, Fig. 3, shows an example of the tractor type. As will be seen from the illustration, it runs on a pair of rack rails and can travel right across the moulding shop on its own power, derived from an electric motor. The machine travels into the sand heap, collecting the sand from the floor by means of a right and left-hand cutting screw conveyor. This carries the sand to the centre of the machine, where it is raised for use by means of a bucket conveyor. When the buckets reach the top they are tipped into a scoop, and the sand is led on to the screen of an oscillating riddle. All large material remains on the top of the screen, but eventually works to the front end, where it is led into a chute and falls into a scrap-box on the main arm of the machine. Whatever sand passes through the riddle is conveyed to a hopper mounted on the swinging arm of the machine and falls through it on to an endless belt, which carries it to the impelling head. From this it is flung out with great speed, due to the centrifugal force given to it, by a rotating paddle. It may be stated that it does not merely throw sand at a high velocity, but actually forms it into wads or compressed handfuls preparatory to projecting it into the box. A single blade is fitted in the impeller, and as this is the only part of the machine liable to wear out quickly, a simple iron casting, costing but little and quickly renewable, has been designed to ensure cheap and convenient replacement. Actually 10 cub. ft. are forced out each minute by the impeller, and as the impeller head is mounted on a long radius arm, the sand may be thrown with great force into boxes to each side of the track. In the demonstration given in the Exhibition, with one size of the standard machine, evidence is afforded of the good quality of the moulds produced by this method. Three separate electric motors are used in performing the operations of lifting the sand, screening it, and impelling it into the moulding-box.

The machine is made in three sizes, specified by the length of the sand-cutting screw as 9 ft., 11 ft., and 13 ft. The stationary type of machine is available for those foundries which have sand conveyors or other means of supplying sand. The portable type is used in general jobbing foundries. It can be placed at any position on the floor and moved to new positions by means of a crane. Travel at a rate of 250 ft. per minute is provided by its own power for the locomotive type, which can be moved along its rails to deal with any size of ordinary work or to ram a pit job to 6 ft. below the floor level.

The Fordath bowl mixer, made by the Fordath Engineering Company, Limited, of Hamblet Works, West Bromwich, is a new introduction of very simple design. It consists of a heavy cast-iron bowl on which a system of arms is revolved by means of a vertical shaft receiving its motion from a fast pulley by means of bevel gearing. The arms are shaped to ensure that everything within the bowl is intimately associated as the rotation proceeds. It is used to mix all types of core mixtures, sands and compounds, and will deal with 1½ cwt. of sand at one time, completing the mixing in five minutes. Uniformity of the finished product is claimed for this machine, which will not only mix liquids with dry or damp core sand, but will also mix solids or paste with sand.

For the exhibit of Messrs. J. W. Jackman and Co., Limited, of Vulcan Works, Blackfriars-road, Manchester, examples of moulding machines are shown with which a great variety of work can be efficiently performed, ranging from miscellaneous jobbing work, when only a few moulds are made from each pattern, to machines for continuous repetition work. In the Osborn type roll-over jolter which takes boxes up to 36 in. sq. there are many features not commonly found in such machines. The jolt cylinder is provided with an easily adjustable compression valve to vary the length of stroke at will. The box is rolled over by power, one valve sufficing for the operation of this process as well as to draw the pattern. A special levelling carriage ensures true alignment of the mould during the draw. This is swung under the mould after it is rolled over. For this machine the pattern is drawn vertically out of the mould without any side play. Once the pattern is withdrawn the carriage is swung out from the machine, and the table is rolled back by power ready for use. A smaller machine taking boxes 24 in. by 30 in. is also shown by Messrs. J. W. Jackman and Co., Limited, which is similar to that already described except that the roll-over is effected by hand. This, however, is made easy, as an aluminium alloy is used for the construction of the table. Complete sand blast equipments of three types, the rotating table, the jerking drum, and a third of a very simple character, form part of the exhibit which contains many examples of a great variety of foundry plant.

A ram moulding machine with a hand jolting system is perhaps the most interesting feature on the stand of Messrs. John M. Terry and Co., of 5 to 7, Great Hampton-street, Birmingham. The machine in question is manufactured by the Denbigh Engineering Company, Limited, of Tipton. The manner by which it is made possible to jolt a heavy load through a hand lever is very interesting. It is effected by the balancing of the load by an oil compensating device. This can be adjusted to suit the load requirements of a specific piece of work in a very short time and thus the hand jolting system is relieved of excessive pressure due to the load and can be operated quite easily.

Necol plastic wood is a material of the consistency of thick paste or moist dough, and in its plastic condition can adhere with great firmness to wood or metal. As this substance, which is manufactured by Messrs. Necol Industrial Collodions, Limited, of Windsor House, Victoria-street, London, S.W.1, can be moulded by hand into any conceivable form, it is useful to the pattern-maker. Articles can be built up entirely from plastic wood in thin layers, each of which is allowed to harden before the others are proceeded with. This material is very usefully employed in that way or on a base of wood in the case of heavy work.

The common motion given to a mechanically operated riddle is a simple oscillation, but Messrs. John Macdonald and Co., of Pollockshaws, Glasgow, have introduced a riddle in which the movement obtained from a ¼ h.p. electric motor, wound either for direct or alternating current, has an elliptical form. This type of movement is claimed to give quicker action, and has the distinct advantage that there is no necessity to use lump-breaking plates or attachments, which soon wear out the screen. This machine is made easily portable through its support being effected by the use of two plain legs and a wheel which permits its propulsion in the same way as a hand barrow.

LETTERS TO THE EDITOR.

THE "TRANSVERTER."

TO THE EDITOR OF ENGINEERING.

SIR,—Major Taylor's letter in your issue of June 20 (page 796) raises two points only. The first infers that direct current has no advantages over alternating current for the transmission of power considering the matter technically. The weight of engineering opinion is so overwhelming in favour of direct current that it is needless on my part to debate it further. His second point is merely a criticism of the transverter from the point of view of efficiency, maintenance and cost.

As "Chartered" has noted, the losses in the transformer unit of the transverter are no greater than in an ordinary E.H.T. transformer. Actually they are less.

Major Taylor has misconstrued this part of the design. For instance, he states that H.T. transformers should not be in an open room but in brick cells. The experimental transverter described in ENGINEERING has a floor interposed between the commutating and transformer units. In the Wembley

transverter the design allows for a wall to separate the two.

Mr. Charles Kay has dealt with the question of line insulation and pointed out the saving that can be effected. My opinion is that on any transmission line of, say, 50 miles the saving in capital cost will be in the neighbourhood of one-third.

Regarding maintenance Major Taylor has taken rotary figures. This is not comparing like with like. For instance, brushes form a considerable part of the maintenance of a rotary. The cost of a set of brushes for a 2,000 kw. rotary will not be less than 30*l*. The cost of a set for a H.T. transverter will be 25*s*. The transverter commutators are entirely different to a rotary in construction and cost, and in view of these differences it is not unreasonable to call Major Taylor's figures imaginary.

Lastly, there is the question of capital cost. Major Taylor has had two guesses and both have been wrong. It would obviously be improper for me to give the actual facts, tempted as I am to do so, and consequently this letter must conclude the correspondence on my part. I thank you for the courtesy you have afforded me in publishing these letters and beg to remain,

Yours faithfully,
W. E. HIGHFIELD.

36, Victoria-street, London, S.W.1., June 24, 1924.

THE OPTICAL SOCIETY.

AT a meeting of the Optical Society held at the Imperial College of Science and Technology, on Thursday, June 12, the following papers were presented and discussed: "*Wide Angle Ortho-Stereoscopy: Its Optical, Practical and Pyschological Advantages*," by Colonel L. E. W. van Albada (Amsterdam). In the paper the author explained his methods for obtaining stereoscopic pictures in which the objects appeared to the observer in their natural sizes and in correct spatial relation. Misapprehensions which had hitherto prevented the use or application of wide-angle stereoscopy were refuted by the author, who showed that the introduction of exaggerated perspective or other unnatural effects was avoided when the stereoscopic photographs were viewed through lenses, which had nearly the same focal lengths as the lenses by means of which they were taken, and provided that the stereoscopic lenses were free from distortion. The advantages of wide-angle stereoscopy were demonstrated by means of a series of stereo-photographs viewed with wide-angle stereoscope lenses of a new type made, at the author's suggestion, by the firm of Messrs. Carl Zeiss, Jena. These lenses were free from colouration and distortion over a field of nearly 80 deg. A new type of wide-angle finder made by the same firm, to the author's design, was also demonstrated. This finder gave a clear image over about 85 deg, with perfect definition up to the edge of the field.

"*Binocular Vision and the Stereoscopic Sense*," by R. J. Trump. In this paper it was contended that, in the appreciation of distance, neither the convergence of the eyes, the visual focus, nor the variation of these accommodations as the eyes sweep over the field, played any vital part. The recognition of a familiar type of perspective system was important, even to the extent of over-riding the evidence of binocular parallax, when the two come into conflict. This might be shown by reversing the mounting of stereoscopic photographs, or by preparing stereo diagrams in which the perspective was not in accord with the parallactic displacements. Parallax, powerful in association with other factors, was uncertain, or even broke down, when not assisted by perspective. There therefore appeared to be no "mechanism" of stereoscopic vision dependent upon binocular parallax, but the perception of distance was a psychological function, involving the interpretation of all the details, similarities and differences, in the images in the two eyes, in the light of previous association and experience.

ROYAL METEOROLOGICAL SOCIETY.

THE last monthly meeting of this society for the present session was held on Wednesday, the 18th inst., at the society's rooms, 49, Cromwell Road, South Kensington, Mr. C. J. P. Cave, M.A., president, in the chair.

The following papers were read and discussed:—1. "*Further Researches into the European Upper Air Data, with Special Reference to the Life History of Cyclones*," by C. K. M. Douglas. The paper stated that a study of individual cases showed that the temperature in the troposphere was much higher over a Bjerknes's "warm sector" than over the other parts of a cyclone. This result lead to the conclusion that a cyclone was superficial in its initial stages. The number of relevant observations was not large, since the "warm sector" only existed during the development of a cyclone, which usually took place in the Atlantic. A large part of the great increase of kinetic energy observed when a cyclone developed was probably supplied by a convectional overturning between adjacent warm and cold masses of air. It was important that the cold mass should have a depth of fully 6 kilometres or 7 kilometres, or about the depth of the troposphere in high latitudes in winter.

2. "*The Effect of the Source of Air on its Temperature at 4,000 Feet and 10,000 Feet*," by Miss L. F. Lewis. In a preliminary note to the paper it was stated that, during the winter months, the chief factor in determining the temperature of the air up to 2,000 ft. was its passage over a large expanse of land or sea. Air which had travelled for 24 hours or more across the Continent was cold, while air from the Atlantic was relatively warm. On the Atlantic, however, some polar effect was shown when the path of the air was followed back for two days or more. In the paper the air considered was that at 4,000 ft. and at 10,000 ft. Trajectories are drawn for two days or longer if possible. The results showed that the chief factor was the north to south component of the air's path, while the land and sea effect was small. The trajectories showed fairly definitely that it was the latitude of the air two days before, or even longer, that determined the temperature.

3. "*A Simple Electrical Time-marking System for Use with Self-Recording Meteorological Instruments*," by L. H. G. Dines. The paper said that accurate timing of self-recording meteorological instruments was not usually attempted in this country. Even at a first-class observatory the time of occurrence of any outstanding meteorological phenomenon was seldom determined with anything approaching the precision that was regularly obtained in other departments of geophysics. The paper described a simple system of synchronous electrical time-marking which was installed a few years ago at Valencia Observatory, Cahirciveen, Co. Kerry, and its application to various kinds of meteorological instruments. A central clock operating hourly and minute contacts in series closed an electrical circuit once an hour. The circuit included electro magnets acting on suitable portions of the recording mechanism of the self-recording instruments which it was desired to include in the scheme. By this means time marks were easily obtained to an accuracy of a second or less.

BRITISH WARSHIPS.—The Admiralty have now placed orders for the two torpedo-boat destroyers included in this year's naval programme. It will be remembered that the firms having experience of this work were invited to submit designs and tenders. One, the "Amazon," is to be built by Messrs. John I. Thornycroft and Co., Limited, Southampton, and the other, the "Ambuscade," by Messrs. Yarrow, Limited, Scotstoun, Glasgow. The first of the surface vessels of our post-war naval programme was launched at Devonport Dockyard on the 18th inst., the ceremony being appropriately performed by Lady Chelmsford, wife of the First Lord of the Admiralty. This vessel named the Adventure—a very old name in the Navy—is the first mine-layer in the Navy to be designed and built specially for her work, all previous mine-layers having been adapted for this special duty. The vessel was designed by Sir Eustace d'Eyncourt, and has a length of 520 ft., a beam of 58 ft., and a displacement of 7,000 tons. It may be added that Messrs. J. Samuel White and Co., of East Cowes, I. of W., have received an order from the Greek Government for six 45-ft. steam pinnaces.

BRITISH STANDARD ROLLED STEEL SECTIONS FOR STRUCTURAL PURPOSES.—The British Engineering Standards Association has published the complete edition of the Section Book (Report No. 6-1924) giving the geometrical properties of the revised British Standard Rolled Steel Sections for Structural purposes issued in 1920. It gives the values of the geometrical properties for all standard thicknesses; hitherto those relating to the minimum thicknesses only have been published. In addition to the tables, the introduction to the original book published in 1904 has been revised and included as an explanation of the quantities printed in the lists with a few examples of their application in designing. The properties of the sections have been calculated on the exact formulæ which were used in obtaining those for the original Section Book, but for the convenience of designers a series of approximate formulæ has been given by which the geometrical properties of intermediate sizes of the standard sections, standard sections having web thickness other than those given in the lists of sections of similar proportions to the standards, can be obtained. These formulæ are believed to be more exact than any approximate formulæ hitherto published. The tables are divided into two parts, the first part giving the values in British measure which are the standard, the second part, which has been prepared for the convenience of users in countries in which the metric system obtains, giving the metric equivalents, deduced from the British values and correct to the last decimal place. The Book is bound in a strong cloth cover to withstand continued use; copies may be obtained from the B.E.S.A. Publication Department, 28, Victoria-street, London, S.W.1, at the price 5*s*. 3*d*. post free.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—While the rate of output compares very favourably in the aggregate with the record of normal periods pre-war, considered in conjunction with the great extensions which have been made to steel works plant during recent years, it leaves much to be desired. The latest reports from big engineering firms operating in South Yorkshire furnish further evidence, if this were necessary, of the exceptional difficulties under which industry is labouring. The passing of dividend payments has become the rule rather than the exception, and where distributions are made, this is generally at the expense of a reduced carry-forward for financing future operations. Competition in new business for the construction of heavy industrial plant continues exceptionally keen, and though works in this district are fairly well employed, prices still remain very low, and, in some instances, barely remunerative. Incidentally, it is worthy of note that Messrs. Davy Brothers, Limited, engineers, of Sheffield, have just completed at a cost of about 50,000*l*., and now have in operation, a new iron foundry at Darnall which is equipped with ample crane power and labour-saving appliances This foundry should prove of great advantage to the firm in the development of their business in steel works machinery both for home and foreign use. The heavy steel branches reflect the force of increased foreign competition, particularly in regard to soft and hard billets. Producers are being pushed, in view of the recent reductions in fuel prices, to offer more attractive rates for forward supplies, but so far they have been unable to make any appreciable response owing to the fact that the unfair burden of overhead costs which they have to bear in comparison with that borne by foreign makers, swallows up the advantage derived from cheaper coal, and leaves quotations, they claim, largely unremunerative. Meanwhile, foreign steel is being imported in larger quantities, and local output is on the decline. On the other hand, substantial business has been booked in machinery cutting-parts, tools, and implements, notably with Colonial buyers. The building trades dispute obscures the outlook in regard to tools and materials for that industry, in which an increased business has been transacted within recent months.

South Yorkshire Coal Trade.—Though the tone of the market reflects widespread weakness consequent on the slump in the export demand and the quietude of home purchases, there has been no further pruning of official quotations. Stocks of industrial fuel are beginning to accumulate at collieries, and restricted production is forecasted unless an early improvement takes place. Best steams, on the whole, are fairly steady, though quiet. The demand for bunkering coal has fallen considerably. Cobbles and nuts are uniformly weak. Only in best quality slacks is there any marked activity. Household supplies are more than ample to meet the demand. Quotations: Best branch handpicked, 34*s*. to 35*s*.; Barnsley best silkstone, 28*s*. to 29*s*.; Derbyshire best brights, 28*s*. to 30*s*.; Derbyshire best house, 25*s*. to 29*s*.; Derbyshire best large nuts, 24*s*. to 25*s*.; Derbyshire best small nuts, 18*s*. 6*d*. to 20*s*. 6*d*.; Yorkshire hards, 23*s* to 24*s*.; Derbyshire hards, 21*s*. 6*d*. to 23*s*. 6*d*.; rough slacks, 12*s*. 6*d*. to 13*s*. 6*d*.; nutty slacks, 12*s*. to 13*s*.; smalls, 8*s*. to 10*s*.

MOTOR OMNIBUSES AND SAFETY.—Mechanical traction is not always free from troubles involving the safety of the public. The London General Omnibus Company, whenever confronted with new conditions, have endeavoured to find effective solutions and to see that their men are well trained in their use. Recently, there have been three accidents in which the victims were pinned below the 'buses. Tests were immediately undertaken to find a suitable type of jack to lift one end of a 'bus from the road. A suitable appliance has been designed, and jacks of 10-ton capacity are now stored at various convenient points in the principal thoroughfares, at Underground stations, the companies' garages, and at all police and ambulance stations. From a recent demonstration of their use it was obvious that a 'bus can be raised in a few seconds to a height sufficient to make a rescue possible. A skidding test has now been introduced into the company's training system, and a smooth-surfaced yard at the School in Chelsea has been treated with oil and grease as a practice ground for the drivers in the means of avoiding skidding.

LOWER THAMES ROAD TUNNEL.—The Minister of Transport, Mr. H. Gosling, M.P., on Tuesday, the 24th inst., received a deputation of the various Local Authorities interested in this project. The deputation was introduced by Mr. G. Isaacs, M.P. All the speakers, Sir Alexander Richardson, Sir Wm. Bull, M.P., Colonel Cornwallis (Kent C.C.), Rear Admiral M. F. Sueter, M.P., Mr. P. Hoffman, M.P., and Colonel Pitt, said the tunnel was necessary for the development of the Lower Thames and for the trade of the Counties of Essex and Kent and the adjoining counties. It was also urged that the tunnel would be an immense factor in the development of the Tilbury Docks and in the solution of the London traffic problem, besides being of very great importance from a strategic and military point of view. Mr. Gosling stated that he was personally greatly in favour of the scheme; it was urgently needed for traffic purposes and would help to relieve unemployment. He added that the Ministry had engaged an eminent engineer to make investigations and to submit a report as to the most suitable site; as soon as the best possible scheme had been prepared, he would immediately confer with the Local Authorities concerned with a view to coming to an agreement as to the work being put in hand.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Prices of Cleveland pig iron are drooping notwithstanding efforts of makers to check the fall, and sales are not easily arranged, buyers' and sellers' ideas as regards values differing somewhat widely. As yet stocks are not heavy, but output is in excess of current needs, and unless demand expands, or production is curtailed, accumulations at makers' yards threaten to assume rather large proportions in the near future. Local foundries are believed to be getting short of supplies, so that the opinion is expressed that founders will come forward with orders shortly. Home inquiries certainly show some little improvement, but they had too few contracts, and export business is practically at a standstill, the Continental financial state holding up overseas trading. No. 1 Cleveland pig may now be put at 94*s.*; No. 3 g.m.b. is obtainable at 89*s.*; No. 4 foundry is 88*s.*; and No. 4 forge, 87*s.*, all f.o.b. Tees; whilst for iron f.o.t. makers' works these figures can be shaded.

Hematite.—There is little doing in East Coast hematite and quotations are on the downward curve. Figures named are, however, still above what customers are prepared to pay. In this branch also the whole of the make is not being taken up, and threatened accumulation of stocks is hampering producers. Nos. 1, 2 and 3 are on sale at 97*s.*; and No. 1 is put at sixpence above mixed Nos.

Foreign Ore.—There is next to nothing doing in foreign ore and prices are difficult to fix. The disposal of an odd cargo of best rubio at a little below 23*s.* c.i.f. Tees has established sellers' quotations on the basis of that figure for best rubio, but customers are not at all disposed to negotiate.

Blastfurnace Coke.—Durham blastfurnace coke is easy. Sales are few and the price of good medium qualities varies from 27*s.* to 27*s.* 6*d.* delivered to consumers here.

Manufactured Iron and Steel.—The situation as regards manufactured iron and steel is such as to cause a good deal of anxiety. Demand generally is poor, and as producers are not securing orders to follow on contracts fast approaching completion reductions in quotations would create no surprise. The only branch really busy is the galvanised corrugated sheet department. Not only are makers of these articles fully booked up for the next few months, but demand keeps heavy, and orders have had to be turned down. Common iron bars are 12*l.* 10*s.*; iron rivets, 14*l.* 5*s.*; packing (parallel), 9*l.*; packing (tapered), 12*l.*; steel billets (soft), 9*l.*; steel billets (medium), 10*l.*; steel billets (hard), 10*l.* 5*s.*; steel boiler plates, 13*l.* 10*s.*; steel ship, bridge and tank plates 10*l.* 5*s.*; steel angles, 10*l.*; steel joists, 10*l.*; heavy sections of steel rails, 9*l.*; and fish plates, 13*l.* The foregoing prices are the agreed on quotations for home trade. Manufacturers are keenly cutting prices for export business. The export quotation for galvanised corrugated sheets (24 in. gauge) is 18*l.* 5*s.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—A dull and quiet state still prevails in the Scottish steel trade and no improvement has taken place in the outlook. The current demand is of a limited character and little of it is made up of ship plates. For sectional material there is again rather a better demand but this falls far short of what is expected about this time of the year. Conditions in the black sheet trade show some improvement, but it is largely confined to the lighter gauges for which the foreign demand has increased to a considerable extent lately. Both India and South Africa have been buying galvanised sheets, while South American consumers have also been in the market. The demand for heavy gauge sheets is not very encouraging at the moment. The inquiry for steel material overall is not good, and forward prospects are not very bright. Home prices are unchanged with boiler plates at 13*l.* 10*s.* per ton; ship plates, 10*l.* 5*s.* per ton; sections, 10*l.* per ton; and sheets, $\frac{3}{16}$ in. to $\frac{1}{8}$ in., 12*l.* 10*s.* per ton, all d/d Glasgow stations.

Malleable Iron Trade.—There is little doing in the West of Scotland malleable iron trade, and a full week's running can scarcely be obtained. The day-to-day demand is still very poor and inquiries do not amount to anything approaching a satisfactory tonnage. Prices keep steady and "Crown" bars are quoted at 12*l.* 10*s.* per ton, d/d Glasgow stations.

Scottish Pig-Iron Trade.—Instead of the Scottish pig-iron trade showing any improvement the tendency is rather the other way this week. Buyers are again holding back, and there is little movement either on home or export account. Makers are finding difficulty in disposing of the reduced current production, and as stocks are once more increasing several furnaces are to be blown out. Prices are again easier and the following may be taken as to-day's quotations: Hematite, 5*l.* 1*s.* 3*d.* per ton, d/d at the steel works; foundry iron, No. 1, 5*l.* 3*s.* 9*d.* per ton, and No. 3, 4*l.* 18*s.* 9*d.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, June 21, amounted to 922 tons. Of that total 827 tons went foreign and 95 tons coastwise. For the corresponding week of last year the figures were 557 tons foreign and 80 tons coastwise, making a total shipment of 637 tons.

Bridgebuilding Contract.—The Newry Harbour Board, subject to the approval of the Northern Government, which is giving a subsidy towards it, have accepted the tender of Sir William Arrol and Co., Limited, Glasgow, to build a modern swing bridge over the Newry Canal.

Clyde Shipbuilding.—The High Commissioner for India has placed an order with Messrs. William Simons and Co., Renfrew, for a twin-screw cable steamer for the India Government Telegraph Service. This vessel will be built under the direction of Sir J. H. Biles and Co., naval architects and consulting engineers, London and Glasgow.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—New business in the coal markets is showing a little expansion although not on a sufficiently heavy scale to improve the general situation materially. All the pits at Ferndale owned by D. Davis and Sons, Limited, which were affected by the disastrous fire at the Company's power station some weeks ago have restarted, but full outputs will not be regained for some little time. On the other hand there is no sign of collieries closed down as unremunerative being restarted, while several more pits will be stopped at the end of the month. There is quite a good demand for the best Admiralty and certain other classes of large and the best descriptions of smalls, but the lower grades are quiet and a number of temporary pit stoppages have resulted from the failure to clear wagons regularly. Arrivals of tonange have been heavier and it is now the rule for the loading berths at the docks to be well employed, with vessels waiting turn for tips. Shipments of coal as cargo last week amounted to 418,468 tons as compared wth 414,411 tons for the previous week. Of the total, shipments to France were 181,398 tons compared with 171,195 tons, to Italy 33,452 tons compared with 44,638 tons, to South America 63,408 tons compared with 50,378 tons, to Spain 28,436 tons against 54,135 tons, to Portugal 15,035 tons against 6,857 tons, to Greece 4,514 tons against 15,658 tons, to British coaling depots 37,821 tons against 31, 374 tons, to U.S.A. 4,400 tons against nil, to Canada 1,647 tons against 3,926 tons, to Belgium 8,399 tons against 7,063 tons, to Holland 6,390 tons against 3,503 tons, to the Irish Free State 8,682 tons against 5,042 tons, and to unclassified countries 24,886 tons against 20,642 tons. Prices are a little harder in the best Admiralty qualities of large which realise 28*s.* to 28*s.* 6*d.* per ton f.o.b., but others are unaltered, Monmouthshires ranging from 24*s.* to 27*s.*, smalls from 15*s.* to 19*s.*, according to quality.

Iron and Steel.—Exports of iron and steel products from South Wales last week totalled 20,332 tons compared with 5,902 tons in the previous week. Shipments of tin plates amounted to 10,222 tons against 3,028 tons, black plates 6,933 tons against 375 tons, galvanised sheets 1,937 tons against 2,014 tons and other iron and steel 1,230 tons against 485 tons.

THE CITY OF CHESTER.—Messrs. Brookhirst Switchgear, Limited, Northgate Works, Chester, have just published an admirably illustrated pamphlet dealing with the City of Chester. It gives a brief history of the Roman city, also of Chester in the mediæval times, and a brief account of the company's business.

"VICKERS' NEWS."—We have received the first issue of this illustrated publication, which is being brought out by the staff of Messrs. Vickers, Limited, primarily in the interest of the group staffs of the various establishments belonging to the firm. This first issue gives information on the clubs, entertainment and other societies run by the members of the different works. The journal also contains advertisements; we find no mention in these of the firm's sewing machine, an excellent machine, which is not as well known as it should be.

INSTITUTE OF METALS.—In connection with the autumn meeting of this Institute, which is to be held in London during the four days commencing Monday, September 8, a programme has been prepared which includes a lecture by Mr. W. M. Corse, of the National Research Board, United States. It also includes the usual meetings for the reading and discussion of papers; luncheon at the Connaught Rooms, Kingsway; visits to the British Empire Exhibition, to works, and to other places of interest; a reception at the National Physical Laboratory, Teddington, and an excursion on the Thames.

THE KELVIN CENTENARY CELEBRATIONS, 1924.—On July 10, the day before the Kelvin Centenary Banquet at the Connaught Rooms, three interesting functions will take place at the Institution of Civil Engineers, Great George-street. At 4.30 p.m., the Kelvin Medal will be presented to Dr. Elihu Thomson (U.S.A.), Sir Charles Morgan, President of the Institution of Civil Engineers, in the chair. This will be followed immediately by the reception of written addresses from the scientific societies of the British Dominions and foreign countries, with Sir Richard Glazebrook in the chair. Sir J. J. Thomson will then deliver the Kelvin oration, Sir Richard Glazebrook in the chair. In the same building there will be available for the inspection of visitors an exhibit of Kelvin experimental apparatus which has been collected by the Kelvin Centenary Committee specially for this commemoration. The Glasgow celebrations were arranged in connection with the University Commemoration Day, June 25, when Dr. Alexander Russell, President of the Institution of Electrical Engineers, who was one of Lord Kelvin's students, delivered the oration.

NOTICES OF MEETINGS.

THE PHYSICAL SOCIETY OF LONDON.—To-night at 5 p.m. at King's College, Strand, W.C.2. "The Electron Emission Constants of Metals," by Prof. O. W. Richardson, F.R.S. A Demonstration of "The Fluorescence of Transparent Fused Silica," by Dr. W. E. Curtis. A Demonstration of "A Selenium Photometer," by Dr. F. C. Toy. "A Method for Measuring very Small Capacities," by L. Hartshorn, D.I.C. A Demonstration of "A New String Galvanometer," by Prof. Ernest Wilson.

THE ROYAL SOCIETY OF ARTS. INDIAN SECTION.—Monday, June 30, at 4.30 p.m., at John Street, Adelphi, W.C.2. "The Art of the Pâl Empire in Bengal," by J. C. French, I.C.S.

THE INSTITUTION OF CIVIL ENGINEERS.—Thursday, July 3, at 5 p.m., at Great George-street, S.W.1. Extra Meeting. Joint Meeting with the following bodies: The Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Naval Architects, the Institute of Marine Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the Institution of Gas Engineers, the British Electrical and Allied Manufacturers' Association, the British Engineers' Association, which are co-operating in the work of the Special Committee on Tabulating the Results of Heat-Engine and Boiler Trials. A paper will be presented by Captain H. Riall Sankey, C.B., C.B.E., Chairman of the Committee upon "The General Scope and Objects of the Work of the Committee," to be followed by a general discussion on debatable points.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Saturday, July 5, at 11.30 a.m., at Storeys-Gate, S.W.1. Joint Meeting with the Institution of Civil Engineers, "Draft Standard Test Code for Hydraulic Power Plants," drawn up by a Joint Committee of the Institutions of Civil and Mechanical Engineers.

THE FIRST WORLD POWER CONFERENCE.—Monday, June 30, to Friday, July 11, at the British Empire Exhibition, Wembley. Monday, June 30, at 3.30 p.m., Official Opening. Tuesday, July 1, at 10.15 a.m., afternoon at 2.30 p.m., to Friday, July 11, at 10.15 a.m., afternoon at 2.15 p.m., Reading and Discussion of Technical Papers. Saturday, July 12, to Tuesday, July 15, various excursions and visits to works and places of interest.

RESEARCH ASSOCIATION OF BRITISH MOTOR AND ALLIED MANUFACTURES.—The fourth annual report of the council of this association, for the year ending March 31 last, gives evidence of the important researches carried out in regard to springs, carburettors, radiators, lubrication, &c. The members of the association are prominent motor-car and metallurgical firms, and the research departments contain the names of expert scientists Their work is to assist the British automobile industry.

PERSONAL.—Messrs. A. F. Craig and Co., Limited, engineers, Paisley, announce that they have moved their London Office from 12, Old Jewry Chambers, E.C.2, to Abbey House, 2-8, Victoria-street, Westminster, S.W.1. Their Telephone number is Victoria 6849.—Mr. James A. Smith, M.I.N.A., F.C.M.S., has removed his offices from 1, Devonshire-square, Bishopsgate, to 11, Haymarket, London, S.W.1.—Mr. George N. Cook, M.I.Mech.E., has, for reasons of health, relinquished the management of the Beardmore Steel Foundries at Parkhead and Mossend, but he still remains with Messrs. William Beardmore and Company, as a consultant and representative in England.—Mr. Roger T. Smith, having retired from the position of Electrical Engineer to the Great Western Railway, has joined the firm of J. S. and W. E. Highfield, Consulting Engineers, 36, Victoria-street, London, S.W.1. The firm will in future be known as Highfield and Roger Smith, Consulting Engineers, at above address.

SPINEL.—Spinel is a magnesium aluminate occurring in different colours, chiefly red, blue-green and black. Spinel has been found in many scattered localities in small amounts; deposits of sufficient size to have an economic significance are not known to occur. Spinel has never been used commercially except the rare transparent blue and red varieties which have been used as gems. While the natural spinel has been of little economic value, it is interesting to note that an artificial spinel, produced by synthesis from its compounds displays very interesting commercial properties. This synthetic spinel is made by the combination of magnesium oxide from magnesite and aluminium oxide from the mineral alunite, which occurs in large quantities at Marysvale, Utah. During the world war when imports of foreign potash were cut off, these deposits of alunite were exploited for their potash content. The mineral was first roasted, rendering the potash soluble so that it could be extracted by leaching. The aluminium oxide content of the residue after leaching was approximately 95 per cent. The synthesis is accomplished by electrical fusion, the spinel appearing in beautifully crystallised masses. This material when bonded in the form of bricks possesses remarkable refractory properties which have made it valuable for many commercial purposes. Information regarding spinel and various other little known non-metallic minerals is contained in Serial 2587, issued by the United States Department of the Interior, Bureau of Mines, Washington, D.C.

TURBINES FOR SS. "PRINCIPESSA GIOVANNA" AND "PRINCIPESSA MARIA."

CONSTRUCTED BY MESSRS. FRANCO TOSI, ENGINEERS AND SHIPBUILDERS, LEGNANO AND TARANTO, ITALY.

(*For Description, see Page* 821.)

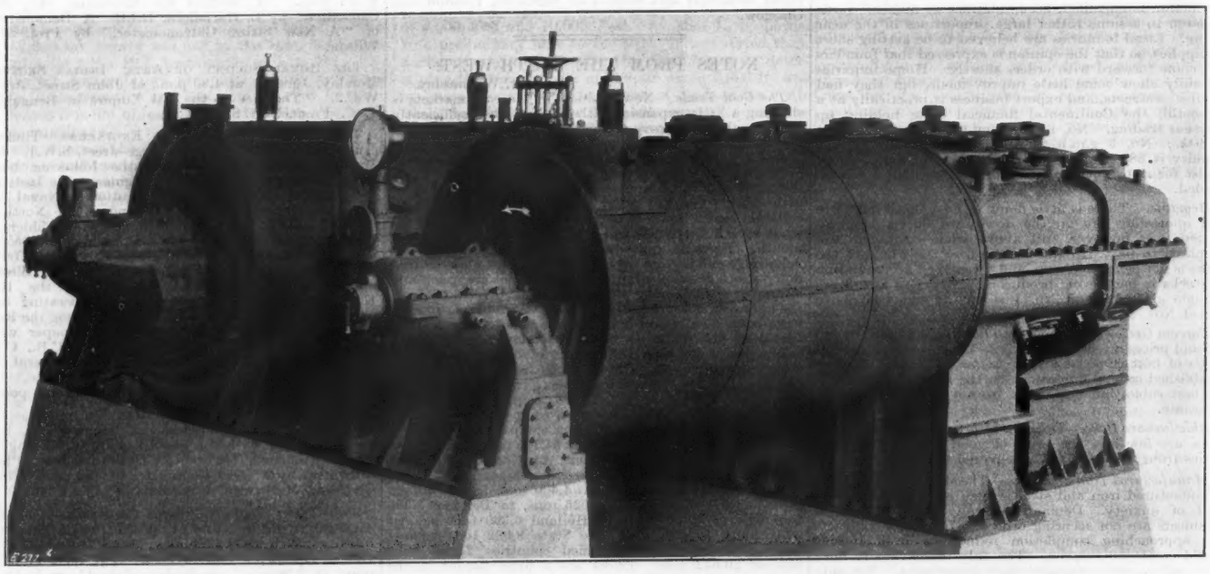


FIG. 14 OUTSIDE VIEW OF ONE SET OF TURBINES.

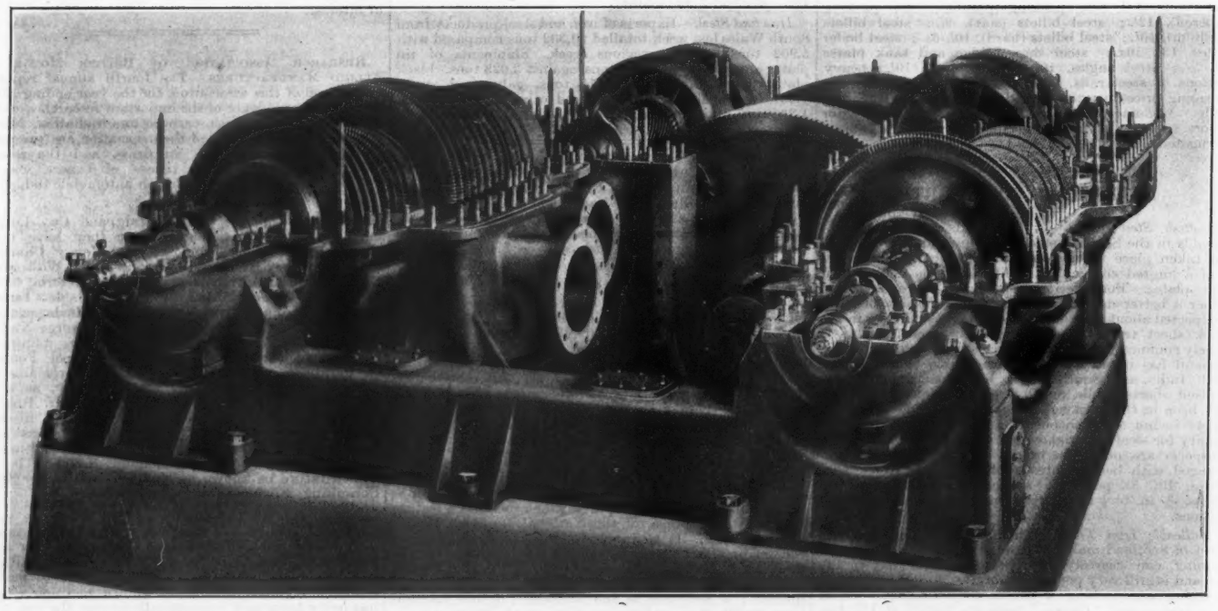


FIG. 15. TURBINE SHOWING BLADING AND GEAR TRANSMISSION.

IGNITION TEMPERATURE OF FUEL OILS UNDER PRESSURE.—In their experiments on the ignition temperatures of fuel oils, F. Schulte (Combustion in Diesel Engines, dissertation, Karlsruhe, 1924) and J. Tauss (Zeitschrift des Vereines Deutscher Ingenieure, May 31) attempted to approach the pressure conditions under which oils are ignited in Diesel engines. The experiments concerned paraffin, petroleum, gas oil, benzine (gasoline), cylinder oil and benzene. Plotting pressures as abscissae (35 atmospheres maximum) against temperatures (up to 700 deg. C.) regular and fairly parallel curves were obtained, the ignition temperatures rising in the order stated. But with mixtures of coal tar oil and shale oil there was less regularity, and atmospheres of air and of oxygen had different influences. The addition of shale oil to tar oil lowered the ignition temperature, in oxygen atmospheres first very rapidly and then slowly, in air atmospheres more uniformly, and the ignition curve in air containing 50 per cent. of oxygen was not the mean between the air and the oxygen curves. These observations accord, in general, with those of Harold Moore (ENGINEERING, January 30, 1920, page 151.) As regards benzene, Schulte does not confirm the very high ignition points (above 700 deg. C.) at high pressures found by some investigators, and for pressures varying between 20 and 40 atmospheres he observed ignition points between 450 and 500 deg. C.

THE RAILWAY YEAR BOOK FOR 1924.—The Railway Year Book for 1924 introduces, of necessity, many changes. The records for 1923, the year covered, of course, by this volume are the first for twelvemonth's operation under the new conditions. The four large groups are now dealt with as companies, and the constituent railways are only noticed in historical paragraphs. The volume for the first time in the series puts on record the organisation of the new and larger companies, and much useful information is given in this connection. The maps of the four Groups, and in some other cases also, are now published as folding plates. This has enabled them to be made much more complete and to a more serviceable scale—points which will be appreciated when reference is made to them. The statistics have been rearranged and those for Great Britain and Ireland segregated. The biographical section has been completely overhauled on account of the changes taking place under the various schemes of reorganisation. On many of the large sections it will be noted that there were in 1923 more non-stop runs of over 100 miles than in 1914, while a large number of trains show a higher average speed in 1923 than in 1914. Sleeping car services were also more numerous last year than in the year before the great war, while the restaurant, buffet and Pullman car services numbered over 600 daily. In view of such facts it may be concluded that in passenger service at least the companies are endeavouring to live up to the spirit of the Railway Act of 1921. The year book from which we draw these facts is published at 5*s.* net by the Railway Publishing Company, Limited, 33, Tothill-street, Westminster, S.W.1.

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received 10 days previous to the day of publication.

All accounts are payable to ENGINEERING, LTD. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford Street, Strand, W.C.2.

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ENGINEERING.

FRIDAY, JUNE 27, 1924.

BRITISH ENGINEERING PRESTIGE.

To a country like Great Britain, whose engineering industry depends very largely upon successful competition in foreign markets, the value of prestige is particularly great. When once a reputation has been established for efficient design, good workmanship, and the satisfactory carrying out of contracts, further business becomes relatively easy to obtain, especially in countries where buyers are far from help if things go wrong, and are thus disposed to consider the character of a firm and of its products as much more important than a slight difference in price. There can be no doubt that the goodwill built up in the past by British manufacturers has been a valuable asset to this country in meeting the competition of other nations, and in so far as integrity in business and quality of workmanship and materials are concerned we do not think there is any falling off from the high standards set by earlier generations. But the prestige which we value so highly was not earned entirely by these characteristics. It was almost equally due to a factor too frequently left out of account in considering trade conditions, yet one which lies at the bottom of every kind of industrial progress. We refer to the enterprise to undertake new developments, combined with the moral courage to incur the risks incidental to them.

The engineering reputation of this country was built up by men who, each in his own way, devised and brought to fruition some advance in the mechanical or constructional arts. Names such as Watt, Stephenson, Whitworth, Bessemer, and many others at once call to mind original inventions which either inaugurated new lines of activity or marked notable developments in various branches of engineering. The efforts of such men placed this country in the forefront of mechanical progress. The consequence of their work and of that of innumerable less famous engineering pioneers was that Great Britain obtained an industrial supremacy which was unchallenged at the time. The material prosperity which accrued to this country from its manufacturers induced other nations to follow our example, and as neither natural resources, energy nor enterprise are the monopolies of any people, the engineering industry soon became firmly established in countries which had previously been our customers. Their only hope of competing effectively with British manufacturers was by endeavouring to excel, and their later start was not altogether a handicap because they began unrestrained by the fetters of traditional practice and were almost compelled to take advantage of the most modern knowledge and methods. The success of their efforts may be measured by the quantity of foreign machinery which is found, not only in the countries of its origin, but also here in England, and frequently in use in the factories of our own engineering firms.

If certain kinds of foreign machines are better than our own, it is not only right that they should be purchased and used by our manufacturers, but it is essential if our factories are to turn out their products most efficiently. The question which has to be answered is why we have, in such instances, allowed ourselves to fall behind the foreigner in designing skill or constructive enterprise. The customer of any other nationality is not likely to be impressed by the arguments of a British salesman of machine tools, for example, if he is informed, as he certainly will be, that the salesman's principals have to buy machine tools of a foreign rival in order to manufacture their own. Every foreign machine unnecessarily imported into this country means much more than the loss of an order by the British manufacturer and a corresponding gain by his rival. It means a loss of prestige to British engineering the effect of which will be to make all subsequent orders more difficult to get. Nothing succeeds like success, and similarly nothing tends more to future failures than failure in the present. In the existing state of industry in this country we cannot afford to fall behind any nation in perfection of design or excellence of construction, for the nation which loses its prestige loses its trade.

There is another point in connection with prestige which deserves the closest consideration of British manufacturers, namely, their reputation as leaders in the design of new machines. We have no cause to be dissatisfied with our past records in this respect, but nothing could be more harmful to our engineering industry than for it to be thought by our customers that to get the latest or most efficient machines they must either purchase abroad or buy from a British maker who manufactures a foreign design under license. Faced with such an alternative, they will naturally prefer to deal with the firm who originated the design in question, feeling sure that the genuine article is more likely to be obtained from its place of origin than from the works of any licensee. This feeling undoubtedly exists, and is responsible for the loss of a considerable amount of trade. Indeed, every machine that the British licensee succeeds in selling is not only an advertisement for the foreign firm who originated the type, but may be regarded by those who do not know better, as a tribute to the superiority of the foreign designer over his British rival. Thanks to the enterprise of our great armament firms and ship-builders the smaller nations of the world regard this country as pre-eminent in all that pertains to warships or mercantile vessels, and valuable orders naturally follow from our prestige in these lines. In such matters the British designer has been encouraged to show what he could do, and his work has placed the industries referred to in a position which could never have been attained had they depended upon the foreigner for inaugurating new developments.

In deprecating the tendency to manufacture to foreign designs, we do not, of course, refer to the acquisition of rights to make articles or machines which represent inventions in the proper sense of the word. We cannot lay claim to any monopoly of inventive talent, and when a real invention originates abroad it would be foolish in the highest degree to deprive our engineering industry of the benefits of making it or our customers of the

opportunity of purchasing it from us. An invention is one thing, and a design, of which only minor and usually unimportant details are even patentable at all, and which could be prepared equally well by any competent draughtsman conversant with the subject is quite another thing. Instances of British firms acquiring rights to manufacture to designs of the latter class are, unfortunately for our prestige, far too common. It is often argued that the purchase of such designs is advantageous on the grounds that the expense of experimental work is saved and production may be started at once. There may be something in the contention, but experience, which is more important than blue-prints, cannot be purchased, and the idea of instant commercial production is largely illusory. Many firms, indeed, make no secret of the fact that they have had to re-design almost entirely the machines which they acquired a licence to make before they were satisfied with them, so that much of the advantage of purchase is lost. Moreover, unless such re-designing is done, the licensee is likely to be always behind the practice of his foreign associate.

The reason why we find so many hyphenated names on the products of British engineering works is a question to which several answers are possible. If it is because our designers have not the technical or practical knowledge requisite to keep pace with requirements or to originate new developments, there must be something very wrong in our methods of engineering education. If our manufacturers find that the graduates of our engineering colleges are not competent, they would be doing a great service to industry and to future generations of students by saying so in no uncertain manner, in order that the defects of teaching might be remedied. If the reason for acquiring foreign designs is to avoid the expense of developing original ones we believe the policy to be very shortsighted, and likely, for the reasons we have indicated, to react unfavourably upon those who adopt it. Furthermore, it appears to customers as a confession of the makers' mistrust of their own knowledge and capacity. Dependence upon outside designers certainly tends to engender such mistrust, and to destroy that enthusiasm of the staff for the products of the firm which would be natural were the firm's own employees responsible for their development and performance. No firm can rightly expect to enjoy a high prestige outside its own walls unless it is a source of pride within them.

THE REQUIREMENTS OF THE OVERSEAS MOTOR MARKET.

At the Empire Automobile Conference held at the British Empire Exhibition on Monday last, under the auspices of the Society of Motor Manufacturers and Traders and the Institution of Automobile Engineers, two papers by Mr. F. A. S. Acres and Captain E. A. Rouch, respectively, that should afford much food for thought to British motor-car constructors, were read and discussed. These papers had been adjudged of equal merit in the competition for the prize of fifty pounds, offered by the Humber Company, Limited, of Coventry, which was divided on the recommendation of the judges, Colonel Cole representing the Humber Company, and Mr. Legros representing the Institution of Automobile Engineers. The first paper dealt with the technical aspects of the problem of design and construction of a suitable car; the second with the commercial side of the manufacturers' business.

In the latter paper Captain Rouch dealt faithfully with the numbers of cars registered in countries overseas, giving comparative figures for the three last years, and proceeded to give the numbers and values of cars imported by the various colonies and dependencies, and to compare the British exports with those of America, the chief of our competitors. The influence of customs tariffs, packing, freight, and routeing were admirably treated, as also were the distribution arrangements and the details of policy and of service—sales, technical, publicity, and financial. Captain Rouch writes with full first-hand knowledge of the Colonial market, and gives much valuable information regarding the type and size of body in demand, the protection required from sun and rain, the storage and supply of spare parts, and their interchangeability. The one paper is the complement of the other, and in order to focus discussion separately on the technical and business sides of the question, a slight revision was made by taking points from one paper and adding them to the corresponding portion of the other, so that the morning session dealt with the technical and engineering side of the subject, the commercial side being treated at the afternoon session.

We have already given attention to the British Colonial motor trade (ENGINEERING, December 28 1923, page 807), and the paper by Mr. Acres, dealing particularly with design and construction, while following the same general views, contains evidence of much careful thought as well as great practical experience. It is with this paper that we shall deal chiefly, because in our opinion the main question is not merely one of recapturing a larger share of an already established market, but the more adventurous preparation for that larger market which should arise when conditions develop—a market which will not only be enlarged by natural increase of population, but also by immigration and the filling up of the, at present, waste spaces of the Colonies. It was remarked in the discussion that cars sold largely by appearance in certain Colonies, that light colours were preferred in some, and that much nickel plating was practically necessary in others. It was further mentioned by Captain Rouch that of the cars in the Colonies and India, over 60 per cent. were sold and used in the principal towns; and yet it was obvious from other remarks made by speakers alluding to conditions in South Africa and Australia, that for these markets labour saving was a most essential feature, and that the paint, varnish, and plating should, wherever possible, be replaced by stoved enamel. The use of the car solely on the good roads of large towns and the satisfaction given by ordinary touring cars of British make, came to the front again in the discussion as an argument in favour of following British home practice, and producing a lighter, more roomy and cheaper car for the overseas market. Nevertheless, it was realised by the overseas technical representatives, particularly by Mr. Chatfield and Mr. Shore, who spoke with considerable knowledge of the work expected of a car in the Colonies, that in addition to general use in towns, runs have to be made to outlying villages, farms or mines, that cars are necessary for enabling business to be transacted by bringing the farmer or the mine-manager to the town, and that the type of car required must be capable of running on dirt roads, of fording streams, of negotiating land either strewn with boulders or recently cleared of forest, and that the car should be capable of dealing with many of the conditions found in cross country motoring.

The advantages that could be gained by individual springing of the wheels were mentioned by Mr. George Watson, who referred to the reduction of inertia effects obtainable by this method, and instanced the Holle car trials; he advocated an approach to the self-locking differential gear with stamped wheels of large angle of path of contact and large boss surfaces. Low mechanical efficiency is an actual advantage in the differential on greasy ground, and he advocated the improvement of the back wheel brakes rather than the fitting of four-wheel brakes on cars intended to compete in the Colonial market, he preferred the right-hand control to the central control, and considered the filtering of dust from the air an advisable precaution, to be accompanied by the connection of the breather to the air filter pipe.

Mr. Chatfield laid stress on the necessity for adhering as nearly as possible to the ordinary conventional lines, so that nothing unknown or untried should be embodied in the design, but this did not mean a slavish copying of existing models. The Ford car, for instance, had good clearance under normal conditions, but when carrying heavy weights or when overloaded, the clearance became reduced and damage could thereby occur to the engine when running over stumps or stones that would ordinarily involve no risk. He advocated a large engine capable of giving 14-h.p., but stated that the petrol consumption must be low, because the already high-price of petrol (3s. 6d. per gallon in South Africa) was increased up-country by the heavy cost of freight overland; he required the car to be easy to jack up and gave reasons for the necessity of big torque at the driving axle.

The trouble caused by deep fords was dealt with by Mr. Shore, who thought that the magneto should be placed 2 ft. 6 in. above the ground, and should be protected from water, whether drawn in through the airway in the radiator or forced in by torrential rain. He laid great stress on the necessity for watertight bonnets and a high carburettor inlet. For colonial work, a cut-out was a useful accessory, the exhaust should be connected to the front instead of to the rear end of the mainfold, with a view to keeping the floor-boards cooler. He considered that a large ratio of power to weight was necessary, that as much unsprung weight as possible should be eliminated, and he pointed out that as, in some Colonies, the tax was based on weight, it was very important that the total weight should be kept low. The semi-elliptic spring ought to be retained because local smiths were accustomed to repairing this type, but the plates should be wider, so as to give increased strength at the central bolt hole and also to diminish the racking wear on the eyes. The question of the early advent of an alcohol or alcohol mixture fuel ought not to be forgotten, and the engine design should allow for conversion to use this alternative to petrol; for this reason he thought the minimum dimensions for a four-cylinder engine should be 85 mm. bore by 140 mm. stroke.

Drawing a sketch of the front aspect of a car on the blackboard, Mr. Legros recommended the audience to examine the four or five cars in the Canadian Pavilion. Three of the Canadian cars, that is to say, cars of American parts and design, but assembled and finished in Canada—showed a clear run through for under-clearance. Moreover, he pointed out, in side aspect the lowest points of engine and gearbox came from 1½ in. to 2 in. above the line touching the lower surfaces of front and back axles. He suggested that they should then examine the fifty odd British cars in the Exhibition, of which less than 20 per cent. in his opinion were worthy of consideration in respect to their suitability to Colonial requirements, and he proceeded to amplify his sketch by filling in the details that in various cars, not mentioned by name, projected into, or occupied portions of, the under-clearance, gradually diminishing this space by introducing a worm drive below the back axle, brake levers projecting downwards from the back brake drums, exhaust box placed low and exhaust pipe bent downwards, battery-box carriers attached below the chassis, and other parts added as afterthoughts. Worse than these, as involving risk of serious damage to engine or gearbox, were the sumps arranged at the lower parts of their casings and liable to foul when passing over undulations in the road or ground. The final result showed a loss of some 25 per cent. to 35 per cent. of the apparent under-clearance. A form of obstruction in some hill roads had been mentioned, consisting of banks of dirt crossing the road transversely, and consequently requiring increased centre clearance in side aspect; this was explained as a measure taken in cases of bad gradients in order to give the hauling team a rest by preventing the load from running back; he instanced a road near Ditchling, in Sussex having this constructional peculiarity. The available effort at the wheel periphery could generally be obtained by calculation from the engine torque, the reduction ratios in the gearbox and in the back axle, and the wheel diameter; but, for purposes of comparison of cars designed for Colonial use, it was as important that this figure (corresponding to the draw-bar pull of a locomotive) should be given, as those of engine h.p., car weight and speeds. A table should be prepared showing the equivalent gradient on smooth hard road that could be climbed by cars having different ratios of car weight to the force exerted at the tyre. Finally, with a pungent reference to the close approximation to zero of the mechanical efficiency of the ordinary car jack, he mentioned the advantage of carrying a long wooden wedge, up which a wheel

could be run, so that the operation of lifting the load several inches could be reduced to that of taking the weight only.

Other speakers, including Mr. Max Lawrence and Mr. Evans, made interesting remarks, the chief being that a committee should be formed to investigate the whole question, to weigh all the facts and arguments that had been raised, and to advise the motor trade on the subject.

In his reply Mr. Acres showed that the matters raised had practically all received consideration in the preparation of the paper; he mentioned, for instance, that with suitably designed dished wheels the provision of two spare wheels would allow of fitting these so as to give the same result as obtained with twin tyres. It is to be hoped that the services of Mr. Acres may be available in the event of the formation of the proposed committee. Where such diversity of views is shown, and where such a wide range of conditions must be met, it is extremely desirable that a skeleton specification should be drawn up by a body of technical men having first-hand knowledge of the practical problems of design, aided and supplemented by those technical men who also have personal knowledge of the Colonies—an experience not merely confined to the towns, but including actually driving cars from town to town, encountering all the extremes of temperature, weather, ground and gradient, and having knowledge of Colonial labour conditions, so that allowance can be made for the ignorance in mechanical matters of the African negro, for the want of physical strength of many of the native servants in India, and for the necessity of being able to get home in the wilder parts of the countries.

Comparison between the Canadian and British cars shows clearly the direction in which the future market lies, and, unless Mr. Legros and Mr. Acres are wrong, car design adapted to Colonial requirements, for all except purely town work, requires revision by giving greater and more uniform clearance, greater protection from water and effects of temperature, better springing, non-rigid engine and radiator supports, improved suspension generally, and an all-round improvement in lubrication methods.

By such a committee the essential may be sifted from the merely desirable, and a car may be evolved that will comprise sufficient elasticity in its design to provide for change in the type of fuel, that will be capable of dealing with great differences of altitude and temperature, that will be an important factor in connecting the individual outlying farm, ranch, or mine with rail, road, and civilisation and give a chance to British motor manufacturers to regain a British market that should never have been lost.

FACTORY ACT REGULATION.

IN the case of Howlett *v.* Shaw, Savill and Albion Company, Limited, the Court of Appeal gave a judgment on June 24 of some importance, as to the effect of certain statutory rules and orders made by the Home Secretary under the Factory and Workshop Act, 1901, for the processes of loading, unloading, removing and handling goods in, on or at any dock, wharf or quay, and the processes of loading, unloading or coaling any ship in any dock, harbour or canal. They were expressly made for the protection of persons employed in any of these processes. Under No. 19 of the rules, where a ship which has more than one hatchway is being loaded or unloaded, it is the duty of the owners to fence or cover securely any hatchway, which is not in use, of a hold exceeding 7 ft. 6 in. in depth if the coamings are less than 2 ft. 6 in. in height.

The action was at the instance of a Mrs. Howlett, a widow, for damages against the Shaw, Savill and Albion Company, Limited, for the loss of her son, Henry Howlett, who, she said, met his death owing to a breach by the defendants of the foregoing rule. Henry Howlett was a joiner's labourer, and on December 8, 1922, he was working in the defendants' ss. Kia-ora in King George V. dry dock, when he fell down a hatchway into a hold and was killed. He had lived at home with his mother, the plaintiff, and was her sole support. The Kia-ora had come to the Royal Albert Dock for unloading and the hatches were removed and part of the cargo was unloaded there. In the course of the forenoon, when the ship had gone into dry dock to be overhauled and painted, Howlett went to fetch something for a blacksmith employed by the defendants, and he tripped and fell down the No. 5 hold and was killed. The case was tried before the Lord Chief Justice, and the plaintiff was awarded 450*l.* damages.

The first question in the dispute was a question of fact with which we need not deal at length, namely, whether at the time of the accident the process of unloading was going on. The Lord Chief Justice found as a fact that the process of unloading was not completed, but the Court of Appeal held that although it was incomplete it had so completely stopped that it could not be said that the unloading was still going on within the meaning of the regulation and for that reason the action was not maintainable. We are more concerned, however, with the other question on which the parties were at issue. The defendants contended that Howlett was not a person employed in the process of loading or unloading and that therefore his mother, the plaintiff, had no claim for damages for a breach of the regulation, assuming that there was a breach.

The Lord Chief Justice decided against the defendants on this point. He said that it might be the primary purpose of the regulations to protect persons engaged in the processes referred to, but if these processes were going on and the regulations were not observed the result was that the defendants were in breach of a statutory duty, and it mattered not that the man was not one of the persons engaged in the processes. In the Court of Appeal Lord Justice Banks, after stating that the question was not whether the plaintiff was entitled to any remedy at all but whether she had established her right to the particular form of remedy which she had selected, said that he could not agree with the Lord Chief Justice on the construction of the regulations. No one could succeed in a claim to recover damages for the breach of a statutory regulation unless he could establish a breach of duty owed to himself, and indeed that applied whether the breach was a breach of a statutory or of a common law duty. The question of construction was whether the regulation on which the plaintiff relied was one which established any duty towards her son, because if it did not she could not recover damages for breach of it. The real question was whether Howlett was employed in any of the processes mentioned in the regulation. It was plain on the facts that he was not and never had been. At the time of the accident he was not employed in the process of unloading the vessel, and the action must fail because the plaintiff had failed to show that there had been a breach of duty towards her son. The result of the judgment is that when a person claims damages for a breach of a regulation made under the Factory Act it is not sufficient for the claimant to show merely that the regulation was broken. It must be shown also that the person who was injured through the breach of the regulation was a person towards whom the defendant was under a duty to comply with the regulation.

NOTES.

TRIALS OF HEAT ENGINES AND BOILERS.

ON Thursday next, July 3, a meeting will be held at the Institution of Civil Engineers in connection with the work of the Committee on Tabulating the Results of Heat Engine and Boiler Trials. This committee was instituted in 1922 with the object of establishing thoroughly up-to-date codes for tests of heat engines and boilers. The first committee of the Institution on this subject was established in 1896 and dealt with the thermal efficiency of steam engines. Later, in 1897, a committee was appointed to deal with the tabulation of the results of steam engine and boiler trials, reporting finally in 1902. This report was revised by a later committee in 1913, while in 1905 a report had been drawn up by a committee on internal combustion engine efficiency. The committee appointed in 1922 was composed of four members of each of nine institutions, as well as representatives of two manufacturers' associations. The work has been performed by six sub-committees, one dealing with boilers and steam engines; a second with internal combustion engines; the third with calorific values; and the fourth with methods of measurement and use of instruments. The fifth has had the subject of definitions and values to deal with, and the sixth has handled editorial matters. The committee has drawn up codes for both scientific and also for commercial trials, the latter being much simplified, while the former are intended to be of service in research, and to designers. Eight codes are in hand for various sections of plant, by combinations of which any modern installation can be covered. The codes will be made as simple as possible; the degree of accuracy to be expected will be indicated and suggestions made as to the best methods for particular cases. The meeting on Thursday next is being called in conformity with the policy adopted recently in connection with the standards of comparison for internal combustion engines, in which connection matters were brought up at a meeting which have proved of service in the work of the Committee. The forthcoming meeting will be mainly devoted to steam engines, and it is hoped that discussion will ventilate the views of members and others, particularly on four points. Of these one is the proposal by the Committee now to adopt the gross or higher calorific value instead of the lower value adopted by the 1913 code. The next proposal is the abandonment of the expression "lb. of steam evaporated from and at 212 deg. F." The third is the proposed omission of the term "boiler horse-power"; while the fourth point is whether water and steam meters should be admissible in comprehensive trials for scientific purposes.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.

The summer meetings of the Institution of Heating and Ventilating Engineers was held in London during the week. On Tuesday last, a meeting for the discussion of papers was held in the Langham Hotel. At this, after formal business had been transacted, Mr. E. Herring delivered an address on "Research Work, Its Past, Present and Future." After briefly surveying the investigation work already done, the author revealed that what was being dealt with at present was much restricted by the smallness of the available funds, and he pled for much more substantial support of this very important side of the work of the Institution. A paper on "Heat Transmission from Radiators" was then read by Mr. Alcwyn A. Jones. In this paper the work of Mr. Masao Kinoshita in 1918 was considered as the starting point in research on radiators. He then showed that the amount of heat transmitted from hot water or steam radiators of the ordinary type was proportional to the power 1·3 of the difference between the mean temperature of the circulating fluid and that of the surrounding air. From recent work it was shown that 12 per cent. more heat was given out by a radiator with the pipe connections at top and bottom over that got from one with the two pipes at the foot, and having the same average temperature difference. Figures have now been determined for the radiation from standard radiators and were included in the paper. It was stated that further tests were in progress to investigate the disturbances due to surroundings and to study how far the radiation was changed by the effects of varying velocities of air over the surface. Mr. A. F. Baillie then presented a paper on "Oil Fuel for Central Heating," in which he discussed the advantages of the system, presented some figures of costs of running in individual cases and described items in the plant necessary for the purpose. In the evening a banquet was held at the Langham Hotel, Regent-street, and visits were made to Windsor on Wednesday, and to the British Empire Exhibition, on Thursday.

THE INSTITUTION OF NAVAL ARCHITECTS.

IT has been the custom of the Institution of Naval Architects to hold its summer meetings in some centre of shipbuilding activity at home

or abroad, but this year, because of the British Empire Exhibition, it was decided to hold the meetings in London and invite many of the friends who had shown hospitality to the Institution at former summer meetings to join in the deliberations. Another feature peculiar to this year's summer meetings was that they were arranged in association with the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders. Consequently, the three Institutions united in the endeavour to make the meetings a success worthy and representative of all the shipbuilding activities of Great Britain.

Presidential Address.

At the opening session on Wednesday morning, June 25, His Grace the Duke of Northumberland, President of the Institution of Naval Architects, took the chair.

The Duke of Northumberland, in opening the proceedings, remarked that the present gathering represented a two-fold object. In the first place, it had been the intention of the members of the Institution to make some return for the splendid manner in which they had been received and welcomed in France in 1922 and in Holland last year. In the second place, it was desired to bring together the members of the three principal British engineering societies whose activities were mainly concerned with shipbuilding problems, in order that the welcome to the guests from overseas should assume a fully representative character. Both the Clyde and the Tyne were anxious to participate in this welcome, and the Council of the Institution of Naval Architects had felt that it would be a graceful compliment to their guests, and a happy means of promoting intercourse between the members of the three societies in question, to give them an opportunity of holding a joint summer meeting in London, to be followed by a tour to the shipbuilding centres. This would give the visitors from abroad a glimpse of the shipbuilding facilities in the two great centres of industry, and of some of the beauty spots and objects of interest in the vicinity. In addition to the members of the French and Dutch societies, a delegation from the sister institution in the United States was also invited. The response to the invitations had been good, and a number of prominent representatives of the shipbuilding industries in the countries named had done the Institution the honour to attend the present meeting and take part in its proceedings.

It had become more and more apparent, as the progress of the world led to a wider dissemination of knowledge, that in the field of science there should be frequent and unfettered intercourse between the leading men of all nations, and this occasion was one which he hoped would assist the advancement of naval architecture by the discussions which would follow the reading of the papers and by the personal intercourse between the shipbuilders of various nationalities. It was felt that the British Empire Exhibition—of the great scope of which the visitors would be able to form some idea during their short stay in London—would alone justify the journey to these shores. The Palace of Engineering alone deserved far more attention that could be given to it in a brief visit, but he hoped that the next day many of the members and guests would find an opportunity of appreciating the amazing display of engineering talent which the manufacturers had brought together at that Exhibition.

He felt it was the wish of all that there should be a closer relation between those achievements and the immediate outlook in the industry represented in its scientific aspect, by the three institutions; if such a closer relationship existed the outlook for the industry in this country would be much more favourable than it was. Some of the reasons contributing to the present dearth of orders were well known, as also the uncertainty of outlook prevailing in shipping and shipbuilding, not only in this country but throughout the world. The economic situation of the world, as a result of the Great War and the Russian revolution, was no doubt one of the primary causes, but it was not the only cause. Among the most potent factors in the present situation were to be reckoned the fatal doctrines which had gained such influence in British trade unionism, leading to the deliberate limitation of output; the fatal theory also that the interests of capital and labour were antagonistic; and also the restrictions of production which tended to paralyse energy and initiative and to defy all economic laws. To add to the seriousness of the position, the industry was faced, on the admission of the trade union leaders themselves, with a movement which was nothing but an organised conspiracy, engineered and financed in some cases by our enemies, to destroy not merely capitalism, but the whole trade union system. These evils called for redress, and it was to be hoped that those on whom rested the responsibility for finding a remedy would display a broader statesmanship than would appear to have been displayed in the past.

In concluding, the President repeated the hearty welcome extended by all members to the guests from overseas, and assured them that their presence was much appreciated. He also expressed the fervent hope that their stay on British soil would be fruitful in developing community of interest and in promoting good fellowship between those engaged in similar pursuits in different lands, thereby extending that good will between nations upon which the future happiness of mankind so largely depended.

Ship Design.

After some announcements were made by the Secretary, Mr. R. W. Dana, the Duke of Northumberland called upon Sir John Harvard Biles, K.C.I.E., D.Sc., Hon. Vice-President of the Institution of Naval Architects, to read his paper on "Ship Design." This paper is reprinted in this issue on page 841.

M. Doyère in opening the discussion paid tribute to the author for his valuable work in the profession of naval architecture and to the Institution of Naval Architects for the way in which it had acted in the development of knowledge and the provision of solutions of many of the problems connected with ship design.

Sir Archibald Denny said that it was not to be taken as the opinion of the author that naval architects knew little about their business. The desire was evidently to show the difficulties and to encourage those who must succeed them in efforts towards their solution. It was impossible to design a ship by the use of a few simple formulæ. In the work they needed a combination of imagination, judgment and common sense. In discussing the speed of vessels Sir John had shown that there were gaps in their knowledge and some amount of uncertainty. He (the speaker) had some knowledge of tank experiments, and those associated with their tanks found little to take exception to in the relationship between the model experiments and the experience with actual vessels. In regard to strength the proposal was made in the Committee on Strength, of which Sir Phillip Watts was chairman, to conduct full sized experiments at sea on vessels with the use of some form of strainmeter. The work of design would be much simplified if such experiments were conducted.

Professor Percy A. Hillhouse, D.Sc., referring to the question of who is the designer of a ship, said that a ship was the product of thousands of minds. The shipowner must decide the speed of the vessel, the cargo capacity and the number of passengers. These he specified together with any limitations of draught to be encountered in the service and the height of masts and funnels which could be permitted, in view of the bridges which must be passed under. Some peculiar requests were sometimes made, as for instance the stipulation he once saw that when all the passengers were at one side of the vessel it was not to heel. Again a vessel was once specified which was to have a normal full speed of 14 knots, but be capable of attaining 20 knots in case of emergency. The man who designed the key plan must be given the credit of designing the ship, for it was he who settled the characteristics of the vessel. Peculiar conditions were sometimes met as for example, when the designer got out the ship arrangement and then demanded that the shipbuilders should accept the responsibility for the ship complying with the conditions, although they had had nothing to do with the design side of the work.

Mr. Spanner called attention to the statement in the paper that little, if anything, can be done in the design to prevent collisions at sea, and then described a proposal in which the forepeak was made in such a way that it could be rammed in without carrying back the thrust to the bulkhead. The principal value his proposal had, he said, was in depriving a vessel of the power of piercing another ship.

Sir John Biles then replied and first thanked M. Doyère for his complimentary remarks. He commented on the action of Sir Archibald Denny in wiping out all his hypercritical remarks on the limitations in the deductions that can be made from experimental tank work, so far as their present knowledge extended, as being not the expression of the scientific side of his nature. Sir Archibald was surely not satisfied that the ship experiences and model results were in absolute harmony. Lately he had re-read Mr. Baker's book, and in it he was obliged to say that there was a gap in their knowledge on the question. The point was this. Although a 5 per cent. disparity between the model deductions and the actual experience might be thought quite reasonable it was still necessary to obtain full knowledge. This figure might be due to the different effects of two actions, the first 10 per cent. acting in one way and the second, a fault of 5 per cent., the other way. With complete knowledge the 10 per cent. disparity might be eliminated. Professor Hillhouse had dealt with the human side of the question in his characteristic pleasing way. He was not sure that Mr. Spanner found fault with what was said on the paper in regard to collisions. The directions in which the naval architect was interested in questions of safety at sea was on questions relating to time for boat lowering and sub-divisions of ships. The method of avoiding the results of a collision suggested by Mr. Spanner might be in the right direction. The proposal, as he understood it, he said, was to ensure that the stem would fall in like a concertina on hitting anything; and would act as a buffer in the end of the ship to cushion the shock.

The President then expressed the thanks of the members to Sir John Biles for the interesting contribution he had given them for the opening of the summer meeting, and the members extended a vote of thanks to the author.

Advanced Naval Bases.

The Secretary, Mr. R. W. Dana, then read the paper on "Advanced Naval Bases," contributed by Mr. S. F. Staples and Capt. D. J. Munro, C.M.G., in the absence of the authors. This paper is reprinted on page 837 of this issue.

Admiral Niblack, in opening the discussion, said he could not agree with the authors in regard to their concluding paragraph, in which they referred to a floating base as an alternative to a permanent naval base at Singapore. Invergordon could not be regarded as an advanced naval base, but as a secondary form of permanent base. What he would term an advanced naval base would be one at, say, Zeebrugge during the European War. What was referred to in the paper was better named as a mobile floating base. The position where such a base would be located was a subject that would be decided by the strategist. Once the position was settled, not only must the floating base be taken to its position, but it must be kept supplied with various resources and effectively fortified. In their paper the authors passed over all these circumstances very lightly. In the American Navy they had what they termed a Control Force under an Admiral. In reality, it was an advance base force. In the paper it was suggested that the floating dock would be towed into position and that a ship containing cables, &c., would go on before to prepare moorings. In all these operations naval vessels would need to be drawn off for protection. He was not finding fault, he said, with the suggestion of mobile bases, but rather with the proposal that they were comparable in respect of duty with permanent bases. Singapore, he thought, was an ideal situation for a main advanced base.

Captain Altham, R.N., agreed with the ideas

expressed by the previous speaker. Modern ships of war needed a jumping-off place in which they could remain until attack became possible. The primary issue in questions of bases of any type was not cost or the provision of employment for workmen, but Imperial defence. To send a battle fleet far from its base without facilities for repair was to court disaster. In any case, the provision of floating workshops was not sufficient for the purpose of effecting heavy repairs thousands of miles away from home. The sending out of all the floating equipment necessary for an advanced base of the type suggested in the paper would mean a great strain on shipping and chaos at the advanced base. The costs given in the paper demanded reconsideration. The cost of towing the base out to position, the provision of moorings, the cost of upkeep, must all be considered, and when that was done the financial advantage shown by the figures in the paper would be wiped out. The life of the floating equipment was only 25 years, whereas a permanent base would be useful almost indefinitely.

Mr. W. J. Berry, Director of Naval Construction, said the modern warship was a highly complicated structure and had highly-powered and lightly-built machinery. She also carried a large and intricate electrical installation with many miles of wire and hundreds of motors, besides many delicate instruments for working and fighting the ship. She was also the home of several hundreds of men. It was quite obvious that such ships would soon be inefficient if they could not rely on a base for docking and refitting. Even early types of warships were largely dependent upon a base for their efficiency, and modern progress had accentuated this dependence.

With reference to the technical parts of the paper, with which they were most closely concerned, there was one matter of great interest to a naval architect—the design of the floating dock proposed. He was in agreement with the authors' views on the usefulness of floating docks, and their advantages over graving docks, under certain conditions, had been clearly stated in the paper. He concurred also in the remarks on the necessity for any dock to be able to receive a damaged ship of great draught. A floating dock could be sunk in emergency much deeper than her normal depth line; service docks had, in fact, been lowered until the top deck was practically awash at one end. A floating dock could also be trimmed or listed to any reasonable extent; and this also was occasionally very useful when docking a badly damaged ship. One difficulty that arose with a large floating dock was the depth of water required at the site in order to allow the dock to be sunk. It would be of interest if the authors would state this depth for their dock when sunk to take a 42-ft. draught ship. He noted that they proposed to increase the draught of a dockable ship to 45-ft. by making the height of blocks 18 in. This hardly seemed practicable, for it would be extremely inconvenient even to scrape and paint the plating in this space, and no bottom repairs could be carried out under such conditions. As to the adequacy of the design for the purpose intended, it must be remembered that the life of a dock is much longer than that of a fighting ship; and it was well when fixing the dimensions of a dock to have a substantial margin in every dimension and in lift, over the strict necessities of the moment. Foresight was also required in providing sufficient structural strength for all likely systems of loading. This was done without much trouble in a dock intended for use with merchant ships; but in warships concentrated loads were met with which added to the difficulties of floating dock design. He did not know whether the authors had made any provision in their design for such concentrations of weight; the structural weight and cost of the dock might be appreciably increased if they had not done so.

It had been found that dock workshops were liable to be cramped, and it was frequently impossible to get large work down to the machines. In this design special arrangements, large openings in the decks and a trolley way, had been adopted to overcome the difficulty as far as possible. It was also noticed that there were four travelling cranes installed—a number that had been found necessary on account of the large amount of light gear to be rapidly lifted or moved.

Sir Eustace Tennyson d'Eyncourt agreed that, when carefully considered, floating docks had many advantages over graving docks. The difficulty of moving them were such that all sorts of considerations arose and added enormously to the risk. In times of war such hazardous undertakings required a great amount of screening and defence. They had to balance the advantages and disadvantages, but it must be remembered that a floating base of the type referred to could only be an adjunct to the main base and not a substitute for it.

Le Contre Amiral C. C. Zegers Rijser discussed the question of strength of an advanced naval base and pointed out that it might be necessary for the fleet to return to it to defend it.

Sir Westcott Abell thought Admiral Niblack had misconceived the intention of the authors. Every world-power had to prepare to meet attack, but it came from an unknown direction. The main strategic centre of the British Navy had changed within our memory from the Mediterranean Sea to the North Sea. It was also to be noted that in addition to these ever-changing conditions, when the number of fighting ships had to be cut down by agreement, they must make additional provisions for repairs. One point was not mentioned in the paper. It was that the locations of fixed bases were known whereas the position in which it was intended to place a movable base was not previously known. Advanced bases of the type suggested by the authors demanded every consideration from the naval authorities.

Admiral Power said he had no hesitation in backing up floating docks. They were valuable assets, at any rate in association with other docks. It would be folly to think of towing a floating dock across the ocean after war was started. One of the first things to be done at Singapore was to send a floating dock out and afterwards go on with the graving dock. When a floating dock was intentionally immersed it was no more vulnerable than any other dock.

When Mr. Staples, who had arrived during the discussion, was asked to reply, he said he had been in a motor accident earlier in the day and would prefer to deal with the questions raised in writing.

Mr. Lionel Clark said the idea of floating docks was an old one. Bilge keels and now bulges had made much of the permanent dock equipment useless. A floating dock did not take long to build, and when it was finished the conditions did not so change as to make its reconstruction necessary.

The Duke of Northumberland expressed the thanks of the members to the authors for the preparation of a paper which had created such a good discussion.

Steering in Shallow Waters and Canals.

Mr. G. S. Baker then presented his paper on "The Steering of Ships in Shallow Waters and Canals," in which he gave an account of research work on a number of ships and models. The results of tests to determine the forces acting upon and the manœuvring value of different types of unbalanced rudders in deep water have already been published by Mr. Baker and his colleagues in two papers (see ENGINEERING, vol. cxiii, page 364, and current volume, page 243). The work covered by this paper was an extension of the earlier work. Tests were made on models in shallow water, practically unlimited in area on shallow water with a deep channel in one part, and in a channel proportioned to represent the Suez Canal. Tests with actual ships were also made in the Canal.

The conditions which existed around a ship moving in shallow water, he said, differed considerably from those in deep water in two important respects: the flow around the ship was no longer truly three-dimensional, and the sea room was restricted, and consequently more accurate steering was necessary. The change from three- to two-dimensional flow increased all the pressure and velocity changes in the water. This had a most important effect on the afterbody. The streams had to close around the stern in more or less horizontal planes, and, therefore, with greater curvature than when the flow was three-dimensional, and this more rapid closing in of the streams had to be accomplished with greater rate of change of pressure than before. Breakdown in flow was, therefore, more likely to occur in shoal water. This could be seen in the great increase of eddy formation at the stern of any model or ship when moving from deep to shallow water. These great changes in pressure and the additional eddy formation caused an increase in resistance to propulsion, which became more pronounced as the channel was made more restricted. A second effect of the pressure changes was an increase in virtual mass represented by the ship and its stream line system. Underneath the ship the water gap between the hull bottom and the sea bottom was restricted and the difficulty of maintaining steady streamline flow at this part was aggravated by the frictional drag of the hull. Spasmodic variation of flow was liable to render the ship directionally unstable, particularly if the action occurred in the fore body. When a ship was in a dredged channel or canal the flow of water past the ship was different on the two sides, unless it was able to keep to the centre of the waterway. Any variation in the depth of the channel on the two sides caused an important effect on the character of the flow and resulted in unequal pressures on the two sides of the hull. The differences in pressure on the two sides of the ship exerted a movement tending to make the ship yaw. In approaching a bank, the tendency was to make the ship sheer off the bank or cut into deep water. Whatever the steering value of a rudder may be in shoal water, therefore, it had to deal with a larger virtual mass than in deep water, and contend with yawing moments not there experienced.

The tests gave results, so far as they may be generalised on, which indicated that the increase in virtual mass in shoal water was much greater than was supposed. It was suggested that the yawing moment was in part due to the increased fin effect obtained from the hull deadwood in the two-dimensional flow of shoal water, compared with the three-dimensional flow in deep water. In part, it was due to the propeller conditions. If it were assumed that the propeller slip was 32 per cent. this would increase to 49 per cent. with an average drop of speed of 25 per cent. in the Canal. The thrust of the propeller in shoal water would then be more than double that in deep water at the same speed, and the pressure on unit rudder area in the slip stream would be nearly 30 per cent. greater than in the deep water slip stream. This value rose to 60 per cent. under the conditions of some of the experiments. The relatively high velocity slip stream must mean a considerable drawing of water to the propeller and a slowing down of the flow aft in the surrounding water. It was evident from the results that the slip stream played a greater part in shoal water than in deep, and that for good steering, propellers should be placed sufficiently close together to ensure that the stream lines between the races are not adversely affected by them. The tests also showed that in shoal water the time taken by the ship to turn a given small angle off its course was longer than in deep water, and the delay was largely due to the longer time taken to start the yaw. The side banks of a canal increased this unsteadiness because of the large yawing moment produced by the ship getting near one of the banks. Unsteady steering began to show when the draught exceeded 0·7 times the depth of water, but any attempt to go at high speeds also produced it. The limiting good speed in the Suez Canal for the ships upon which observations were made was about 7 knots for draughts of 23 ft. or less, and 6·5 knots for 26 ft. draught. With a following tide or an ineffective rudder, lower speeds must be adopted. In twin-screw ships the rudder should swing into the screw race at a fairly small angle. In cases where this angle was over 15 degrees, the reputations of the ships for service in the Canal were not good. When a ship through being near a bank developed a bad sheer across the Canal and the helm appeared insufficient to stop it, the better manœuvre was to stop the engine on the bank side rather than go full ahead on the other engine. It was wrong to go astern on the engine at the bank side. The results showed the necessity for the provision of some trustworthy means on the bridge to indicate the exact position of the helm at any

instant and the rate and direction of revolution of the engines.

Mr. Barnaby referred, in opening the discussion, to one of the ships he was interested in on which tests were performed by Mr. Baker. All the deductions from the experimental work were fully borne out in actual experience. He expressed his pleasure that Lloyd's had allowed the increased size of rudder suggested by Mr. Baker without any change in the stock, for it was evidence that they appreciated that the stock in use was not subjected to anything like the stresses, in the canal service, to which it could reasonably be subjected.

Sir John Biles spoke of a case where a skipper had refused to sail his ship again on a service which included narrow channels unless new rudders were fitted. Mr. Baker reproduced the exact conditions in the tank, demonstrated what had occurred and then, after some experimental work, provided a solution. Such cases were good evidence of the value of tank experimental work.

Mr. Baker, in reply, said he had little to do but thank the contributors for their kind remarks. It was not always easy to get facilities for full-scale experimental work, such as was referred to in the paper, and he thanked those people who had granted him facilities. At one time portable pieces were added to rudders on the canal service, but he had found that they had no practical effects except that they made the ship officers steer more carefully.

Sir Thomas Fisher, who arrived during the reply to the discussion, added his testimony to the value of the work done at the experimental tank by referring to steering troubles experienced in the St. Lawrence, and how solutions were found for them at Teddington by experimenting on the tank after modification to represent the conditions.

The President then congratulated the author on the value of his experimental work and expressed the thanks of the Institution for a very valuable contribution.

PASSENGER SHIP DESIGN.

The paper submitted by Messrs. John Anderson and Robert Steele, B.Sc., on "Passenger Ship Design from an Independent Point of View," which we reprint on page 839 of this issue, was then taken as read and discussed.

Mr. A. C. F. Henderson expressed the opinion, in opening the discussion, that it was impossible to eliminate the carrying of cargo from such a ship as was considered in the paper. In the tables given in the paper he found some matters requiring explanation. First there seemed to be no reason why the fresh water carried should be less for the proposed ship than in the Type one. Again, the figures relating to freight rates he could not accept. Ships could not be run on the Atlantic to-day without cargo. Gradual evolution was what caused a change of type to suit altered conditions.

Mr. R. J. Walker pointed out that the figures obtained in the running of geared turbines were much better than those given in the paper. There were many advantages possessed by the geared turbine. It was said in the paper that oil engines consumed approximately 40 per cent. of the fuel per horse-power required for an oil-fuel geared turbine installation. This should be 70 per cent, and when the other factors were brought into the consideration, such as the use of high-pressure air heaters, etc., the balance was in favour of the geared turbine drive.

Mr. F. H. Alexander, M.Sc., welcomed the reconsideration of the question of separate ships for passenger and cargo services. No constant solution was possible, as improvements in ships' machinery and fuel changed the ratio between capital employed and operating expenses. Failure in the attempts made to run vessels exclusively for passenger traffic had nearly always proved to be failures because they were given uneconomical speeds. If there was no greater time spent in port than was necessary for fuelling it became possible to carry on a definite service with fewer ships. He cited a case where it was possible to run the service with six vessels in place of the nine otherwise necessary, because of the time of detention in port to deal with the considerable amounts of cargo that were carried. Were intermediate ships done away with and the two classes of traffic dealt with in vessels designed to suit their specific requirements the same volume of work could be undertaken on less capital and would give an increase of gross profit, which pre-war figures showed us might be not less than 30 per cent.

Mr. John Anderson, in reply, said they had simply put forward an extreme proposal showing what could be obtained by adopting a pure passenger ship. Those doubting some of the figures given of the costs, should make allowance for the great reduction in dimensions obtained for the proposed ship. Mr. Walker showed a difference of outlook on the question of relative efficiencies of oil engines and geared turbines, but he did not expect anyone would claim that the oil fuel used for an oil-fired geared turbine installation was 70 per cent. of that used in oil engines.

The Duke of Northumberland said that although the paper had not been read at the meeting it was to be regarded as a very valuable contribution to their proceedings. He congratulated the authors and called for a vote of thanks to them.

The meeting was then adjourned.

(To be continued.)

THE INSTITUTION OF GAS ENGINEERS.

THE Annual General Meeting of the Institution of Gas Engineers was held on June 24, 25 and 26, at the Institution of Electrical Engineers, and a party representing the Institution left on Thursday afternoon for Paris to attend the Centenary of the Gas Industry in France, the Jubilee of the Société Technique de l'Industrié du Gaz en France, and the Gas Exhibition. The chair was taken by the President, Mr. Samuel Tagg, M.Inst.C.E., and over half the 1,050 members of the Institution were present.

After formal business the Institution Gold Medal was presented to Mr. Stephen Lacey, B.Sc., for his paper on "Flow of Gas in Pipes," and the first Diplomas in Gas Engineering were presented under the Institution's Education Scheme, which was initiated early last year.

Mr. Tagg's Presidential Address was devoted to a survey of progress in the gas industry since the Institution was founded in 1903, and of its technical and industrial outlook at the present time. Technically the period has been marked by the introduction of higher carbonising temperatures through the use of more refractory materials, the relief of manual labour by mechanical means, the development of vertical retort practice and simultaneous water gas production, the improvement of plant for making carburetted and other water gas, and for complete gasification, and the adoption of waste heat boilers. In spite of the reduced consumption in burners through the introduction of the inverted incandescent burner the volume of gas sold has increased by 2·3 per cent. per year, and the load factor has increased from 56 to 69 per cent. The British Commercial Gas Association, founded in 1911, has had unqualified success in its work of publicity and propaganda; gas undertakings have been united more closely by the formation of the National Gas Council in 1916; and by the research work of the Investigation Committee and otherwise the Institution has co-operated with other technical bodies and with individuals, including makers of plant and appliances, in the attack on the technical problems that await solution.

The history of the growth of the electricity service during the same period and the improvement in load factor and profits that has been found to result in some areas from the adoption of multi-part tariffs must stimulate gas undertakings to continue the development of their industry and of the more attractive service it can offer in most competitive fields. In the important department of cost the improved load factor of gas has reduced the average capital charge and interest cost per million cub. ft. sold, though—probably through expenditure on prepayment installations — the capital expenditure per unit plant capacity was higher in 1921 than in 1883. Some companies may find it desirable to increase their provision for depreciation, and at the best no reduction in the costs of coal, oil or labour is likely, though the friendly relations established with labour have facilitated the reasonable adjustment of wages in accordance with the cost of living. The prospect of further reductions in the cost of gas, already low as compared with either pre-war rates or the cost of other sources of heat energy, depends therefore on extension of business, increased values for coke and higher production efficiency.

The reduction in the calorific value of gas has reduced the amount of coke on the market and thus increased its price; but this increased value of coke with the consequent reduction in the cost of coal gas is likely to increase the production of coal gas in place of water gas, and again produce a surplus of coke, for which new markets may have to be developed. Growing public recognition of the evils of unconsumed smoke make it likely that an acceptable solution of the smoke problem would be found, and a sufficient market for surplus coke, if by low temperature carbonisation or otherwise a solid smokeless fuel could be produced to compete in price with coal and be as attractive in use. Such a manufacture, if it turns out ultimately to be technically and economically practicable, would almost certainly pass into the experienced hands of the gas industry. In the meantime practice is tending in the direction of the single stage total gasification of coal and the partial gasification of coke by steam; and on this and similar questions the Institution's Investigation Committee should use the Woodall experimental carbonising plant in the University of Leeds to undertake enquiries that are beyond the resources of most undertakings, and submit the results and safe conclusions from them to a wide circle of workers. In addition to its valuable work on the survey of national coal resources and other general investigations the Fuel Research Board is rendering particular service by co-operating on other questions of national importance relating to high temperature carbonization. There is room and need for further work, such as the Institution's Committees are contributing to the elucidation of practical problems, in the accurate collation of individual experience and in the standardisation of common components of plant, such as the standard specification for refractory materials that the Institution has co-operated in preparing; and with this object a Director of the Institution's technical activities should be appointed.

The Institution seeks the co-operation of users and of manufacturers of plant in its various activities. Its Education Scheme, approved in February, 1923, has been successfully introduced, and will surely and certainly help to progress in the industry. The great co-operative exhibit at Wembley leaves little doubt that, if further funds are wanted for developing the service, the industry will find them. The common interest of the bodies concerned, the wide co-partnership of employees with the undertakings for which they work, and the public benefits of an extended use of gas fuel, will assure and quicken this development.

The Annual Report of the Council and the Report of the Advisory Committee on Education were presented. From the latter report it appears that the education scheme is proceeding satisfactorily in England, is expected to be in full operation in Scotland next session, and should be extended to include lower grades of the gas service.

The Mayor of Preston, Ald. Matthew, attended in order to express the high esteem in which the President of the Institution, who is gas engineer of that town, is held by his fellow townsmen.

Mr. J. Ferguson Bell, M.Inst.C.E., engineer of the Derby Gas Company, was elected president for next year, and on the invitation of the Corporation, it was resolved that the next annual meeting should be held in Derby.

Reports of the Gas Investigation Committee on Aeration in Atmospheric Burners, Waste Heat Boilers attached to Continuous Vertical Retorts, and Standard Methods of Testing Gas Cookers, were received and discussed.

Mr. A. G. Lane read a paper on the Regenerative Coal Gasification at Aylesbury. This is a process devised by Mr. M. W. Travers, F.R.S., and Mr. F. W. Clark, for complete gasification, in which the blow gas from a generator similar to the ordinary water-gas producer gives up sensible heat to a regenerator,

in which it is supplied with secondary air as required, and this heat is recuperated by the steam and by a circulation of gas from the outlet main. The hot gases pass through an upper continuation of the cylindrical generator, and there at once carbonise the coal that provides the coke for the generator, and in the early part of this period get enriched with gas from the coal. Arrangements are provided for controlling the direction and proportions of the steam and circulating gases and the rate of circulation in accordance with the readings of gauges on Venturi meters. The Aylesbury plant has a much higher capacity than the demand, and by reason of having had to utilise pre-existing elements is not proportioned as it would otherwise have been. The consequent very intermittent working detracts considerably from the thermal efficiency of the plant; but nevertheless it has shown a substantial gain in the aggregate therms produced over what would have been obtained by the combination of the water gas and carbonisation processes operated separately. The system includes also special patented arrangements for condensing the steam at the period when it is mixed with rich gas from the carbonising chamber, and for carbonising with oil when desired.

A paper by Dr. S. Penton and Professor J. W. Cobb, described investigation in continuation of work reported by the authors last year on the gasification of coke in steam. In the present paper special attention was paid to rates of gasification and the composition of the gas, separate work being done on medium temperature (900 deg. C.), high temperature (1,270 deg. C.) and bye-product (metallurgical) coke. The experiments were on a laboratory scale, and to some extent are explanatory of results previously obtained by the Gas Investigation Committee in large-scale experiments.

A paper was read by Mr. W. Emery on Silica Gas Retorts, and Mr. J. P. Leather, the honorary secretary of the Committee, introduced the report of the Refractory Materials Joint Research Committee, together with a number of reports to the British Refractories Research Association, presented by permission of the Research Department.

Mr. Gibson read a paper on "The Construction of New Coal Gas Works at Garston."

THE FACTORIES BILL.

IT has been known for some time that the Home Office were engaged in the drafting of a new Bill to consolidate and amend the existing factory legislation. The result of their labours is the Factories Bill which is now awaiting a second reading in the House of Commons. The Bill extends to just under one hundred pages of type, and the labour involved in its preparation must have been very great; but it will be of the greatest advantage to employers and their advisers to have practically the whole legislation on the subject in one statute instead of having to trace it through some nine or ten statutes, as at present; and, under reservation of all criticism of the clauses of the Bill, we think the Home Office and the Factory Department are to be congratulated on their effort to consolidate and simplify the existing legislation. The Bill will require to be carefully considered by all the interests concerned, and in the present article we propose, without offering criticism, to draw attention to the main alterations of the existing law which are involved in the Bill, so far as these are likely to affect the engineering industry.

Perhaps the most striking feature of the Bill is the abolition of the existing distinctions between factories and workshops and between textile and non-textile factories. The provisions of the Bill apply equally to factories, whether textile or non-textile, and workshops. This results at least in simplification.

Part I deals with general health provisions, and includes some requirements as to the maintenance of a reasonable temperature in workrooms and the provision of sufficient and suitable lighting. The Factory Department have for some time been investigating the problem of the setting up of standards of lighting for factories, and it is significant that in clause 6 power is given to the Secretary of State to prescribe by special order a standard of sufficient and suitable lighting. The difficulties involved in an attempt to prescribe such a standard would be very great, but it seems probable that when the Factory Department have progressed sufficiently in their investigations the attempt will be made.

Part II contains general safety provisions, many of which are new and call for careful examination from the technical and practical point of view. Clause 16 contains novel provisions:—In the case of any machinery constructed after the date of the passing of the Act no set-screws, bolts, or keys on any revolving part are to be allowed to project, and all spur and other gearing is to be completely encased; and any person who *sells* or *lets on hire* any machine constructed after the date of the passing of the Act which does not comply with these requirements is to be liable to a fine not exceeding 100*l*. Some of the safety provisions regarding steel boilers are new, and there are new provisions regarding steam receivers and compressed-air receivers; and the Bill provides almost anxiously for means of escape in case of fire.

Part III concerns general welfare provisions. The provision of facilities for washing has in the past been rather a vexed question. Some employers who have gone to considerable expense in fitting up wash-hand basins have found that they were little used, and the maintenance of supplies of towels and soap has led to difficulties which need not be specified. Under the existing legislation and some of the existing statutory orders such facilities have to be provided in certain "dangerous trades," but clause 39 makes the provision of wash-hand basins, soap, and towels compulsory in all factories. Where more than twenty persons are employed there is to be at least one fixed basin for every ten persons. By clause 41 there is to be provided for the use of all female workers whose work is done standing a sufficient number of seats to enable them to take advantage of any opportunities for resting which may occur in the course of their employment. Surely this is too vague. Clause 42: There is to be provided for the use of all persons employed suitable accommodation for clothing put off during working hours, with such arrangements as are reasonably practicable for the drying of wet clothing. The expense involved in compliance with this will require serious consideration. Clause 45 requires that every person employed shall be allowed a weekly rest of not less than 24 hours between 6 p.m. on Saturday and 6 a.m. on Monday, but after consultation with organisations of employers and of workers the Secretary of State may exempt special industries on the ground of the exigencies of the work. The case of continuous processes will obviously require special consideration.

Part IV contains special provisions and regulations regarding health, safety and welfare.

Part V deals with the notification and investigation of accidents and industrial diseases. To a great extent this repeats the existing provisions, but clause 69 is a new provision to the effect that where a Court holds a formal investigation into any accident, or case of disease, occurring or contracted in a factory the Court may require the expense of the investigation to be paid by any person summoned before it who appears to the Court to be responsible for the occurrence.

Part VI contains important provisions as to the employment of women and young persons under 18 years of age. The permissible hours of actual work are reduced from 60 per week, as at present, to 48; but the periods over which the employment may be spread are more elastic than at present. Further, women and young persons are not to be employed continuously for a spell of more than 4½ hours—instead of 5 hours as at present—without an interval of half an hour for a meal. Clause 91 gives effect to many of the recommendations in the recent Report of the Departmental Committee on the Medical Examination of Young Persons for Factory Employment. Instead of certifying surgeons we are to have "appointed doctors." Young persons under 18 years of age—not merely 16, as at present—are not to be employed in factories until they have been certified by the appointed doctor to be fit for the employment; but the certificate, instead of being limited to employment in a particular factory, may be given in respect of employment in any group or class of factories or in any particular process or class of work. The Departmental Committee advised that the school medical records of the young persons should be made available to the appointed doctors so far as necessary. The Bill provides for this being done confidentially. Clause 87 simplifies the existing provisions as to the night employment of young persons, but it does not seem to make any real change so far as engineering is concerned.

We may pass over Parts VII and VIII.

Part IX is important. At present in textile factories, and in the case of moulders in iron and steel foundries, and in some special types of non-textile factories, particulars are to be given to piece-workers to enable them to compute the total amount of their wages. This is now to be extended to practically all piece-workers in factories, whether textile or non-textile. Many of the requirements are the same as those already applicable to non-textile factories, but it may be a question for consideration whether they can be successfully applied to the varied work done in engineering establishments.

The remaining parts of the Bill contain many miscellaneous and administrative provisions, and it need scarcely be said that penalties and legal proceedings are not forgotten. Generally speaking, the penalties under the existing legislation are substantially increased.

The Act is to come into operation on January 1, 1925, but, except where specially provided, it is not to extend to Northern Ireland.

To sum up, the main amendments in the existing law, so far as engineering employers are concerned, seem to be:—

(1) The abolition of the distinctions between textile and non-textile factories and between factories and workshops.

(2) The reduction of the hours of employment of women and young persons.

(3) The requirement of a weekly rest day.

(4) The requirement that particulars of work and wages are to be given to piece-workers in non-textile as well as in textile factories.

(5) The increased stringency of the safety provisions.

(6) The requirements as to the provision of washing facilities and cloakroom accommodation.

We commend the Bill to the consideration of all engineering employers.

18-FT. BED UNIVERSAL PLANO-MILLING MACHINE.

A PLANO-MILLING machine of unusual capacity, built by Messrs. Kendall and Gent (1920), Limited, of Gorton, Manchester, is now being erected at the works of the North Eastern Marine Engineering Company, Limited, of Wallsend-on-Tyne. The machine is primarily intended for machining the segments of large Diesel engine beds, but is of such a universal character that it can deal with most of the large castings used in the construction of marine engines generally. It can also be used for slab milling by means of a horizontal mandrel, either carried right across the machine and driven by both horizontal spindles or from one side spindle only.

Castings up to 18 ft. in length, 12 ft. in width, and 8 ft. in height can be accommodated. The drive is by a series of electric motors, two of 35 h.p. each being coupled to the two vertical spindles, permitting of independent working, while one of 70 h.p., of variable speed, actuates the two horizontal spindles. A fourth independent constant speed reversing motor of 20 h.p., coupled direct to a change-speed box, drives the feed and quick traverse. A wide range of feeds with constant speed quick traverse is obtainable. The cross slide is about 28 ft. in length, weighing, with saddles, about 28 tons. The table is 12 ft. 6 in. wide and is provided with three bearing ways and holding down slips, inside and outside. Twin worms, with heavy ball-thrust bearings, govern the motion, gearing into two semi-circular racks. An equalising motion distributes the work to the worms. The face cutters are 24 in. in diameter. The two vertical spindles are spring balanced, each being fitted with slow variable feed and quick run motion along the cross slide. Each saddle feed works independently, slip motion being provided to avoid the feeds fouling one another. The side heads are balanced and fitted with variable milling feeds and quick-run motion up and down on the face of the

uprights, variously adjustable, and may be controlled from both sides of the machine. Spur gearing connects the 70 h.p. motor situated at the left-hand side of the machine directly to the first driving shaft. Any spindle may be stopped. A hand motion at the base of the right-hand upright is provided, by means of which the machinist can adjust the saddles on the cross slide, on either or both side heads on the uprights, or all simultaneously. All gearing, with the exception of the first driving pinions, which are of compressed paper with mating gear of cast iron, are of steel. The shafts and screws are of 40-ton steel. At full capacity 160 cub. in. of cast iron can be removed per minute, the total weight of the machine being 140 tons. We will hope to deal with this interesting machine more fully in a later issue.

INDUSTRIAL NOTES.

CLAIMS for advances in wages were made at a meeting held last week end of representatives of the railway companies and of the craft unions concerned. At the close the following statement was issued:—"The representatives of the Amalgamated Engineering Union, the United Society of Boilermakers and Iron and Steel Shipbuilders, and the National Union of Foundry Workers, met the Railways' Staff Conference in regard to their application for increased rates of pay and improved conditions of service for railway shopmen. The case of the unions was fully explained to the companies' representatives, who stated that several other bodies had put forward representations on behalf of railway shopmen. It was arranged that after an opportunity had been afforded the railway companies of considering the whole of the applications submitted, a further meeting should be held with the unions represented, on Tuesday, July 8." We understand that the Amalgamated Engineering Union applied for a wage advance of 12*s.* per week on a national basis, with a corresponding increase in piece rates, for all engineers employed in railway shops and running sheds. They asked also that existing running shed differential rates be maintained, the establishment of the principle of payment for holidays, a national rate for apprentices, revision of the rates of young journeymen, and a superannuation scheme for railway shopmen. The Boilermakers' Society and the Foundry Workers also want an advance of 12*s.* per week. The National Union of Railwaymen has also in course of preparation a programme dealing with improved wages for the railway shopmen. The Federation of Engineering and Shipbuilding Trades has lodged a claim for the consolidation in weekly wages of the 16*s.* 6*d.* per week remaining of the original 26*s.* 6*d.* war bonus, and for an advance of 10*s.* per week.

A meeting of building trade employers was held last Friday in London, following the disputes which have arisen in Liverpool and in other cities in regard to the national wages agreement, the summer time number of working hours, and overtime work being also contested points. At the close a resolution was passed, stating that since the various conditions agreed upon and communicated to the operatives' Federation had not been carried out, all offers were withdrawn, and that there would be no further negotiations unless and until all branches of operatives complied with the conditions. The resolution also stated that a national cessation of work was to take place as and from July 5 with the object of insisting upon the observance of national agreements. The lock-out is to apply to all federated firms in England, Scotland and Wales, and will directly involve about 700,000 operatives, members of the 14 unions comprised in the Building Trades Operatives' Federation. Mr. Shaw, the Minister of Labour, has suggested that the operatives and employers should meet again to further review the situation. Meetings are taking place to review the whole situation.

Speaking last Tuesday at the fifty-seventh ordinary general meeting of the Ebbw Vale Steel, Iron and Coal Company, Sir Frederick Mills, Bart., said that the importation of Continental iron and steel had increased to more than the pre-war figure, and was now about 200,000 tons per month. This steel was produced under conditions, both as to wages and hours of work, inferior to those obtaining in this country, and, moreover, paid nothing to represent the charges which fell on the home manufacture in respect of Imperial, local and social obligations. He could not see that sufficient confidence had been gained in the world of finance to justify a hope that international trade was mending. There was a large body of public men—honest enough, no doubt, but, he ventured to think, misguided—who said that the nationalisation of certain key industries notably coal, would be for the public benefit. He, the speaker, among others, was clearly of opinion that if the coal industry were placed under bureaucratic control all incentive to keep the cost down would be lost, and the price of coal would either rise by leaps and bounds, or coal mining be subsidised by the State. In either case, the cost to the community at large would be stupendous. When the State dropped the control of the coal mines in 1921, some months before it was due to do so under the Act, the industry was involving the State in a deficit at the rate of nearly a hundred millions per annum, and there was nothing to suggest that State control would be more efficient in the future than it was then. On the contrary, the predatory speeches and actions of those responsible for these proposals suggested rather that the industry would be administered by men almost devoid of technical and commercial knowledge and experience.

In the course of his statements at the annual meeting of Messrs. John Brown and Co., Limited, Mr. Bernard Firth said the total volume of shipbuilding construction in progress in Great Britain amounted now to one-half of what it was in 1914, whilst the volume of naval ship work was only one-sixth. One serious aspect, he added, was noticeable in connection with shipyard labour, and that was the large number of the most skilled mechanics who were seeking and finding work outside this country, particularly in America, owing, doubtless, to their feelings of uncertainty as regarded employment, aggravated in great measure by repeated labour disputes.

The official returns published by the Ministry of Labour show that the number of workpeople, other than seamen, reported as killed in the course of their employment in Great Britain and Northern Ireland during May last, was 236. This total is made up as follows: Railway service, 20; factories and workshops, 110; mines, underground, 96; mines, surface, 8; quarries, 2.

According to statements published in Germany, the condition of the labour market in that country continued satisfactory on the whole during April, but certain signs of weakness were apparent. The increase in the number of vacancies notified by employers was less than in preceding months; in some industries there was even a perceptible decline in this respect, which, however, was counterbalanced by increases in other directions. Reports from trade unions showed a continued improvement in regard to employment among members of these organisations. On April 26, out of an aggregate membership of 3,825,581 in 37 unions making returns, 396,864, or 10·4 per cent., were out of work, as compared with 16·6 per cent. in the preceding month and 7 per cent. in April, 1923. Statistics relating to short timeworking showed an improvement in April as compared with March. The number of totally unemployed persons in the unoccupied areas in receipt of out of work benefit continued to decline, falling from 462,775 on April 15, to 310,898 on May 1 and 243,268 on May 15.

The Brussels journal *L'Echo de la Bourse* frequently contains very interesting articles on the economical difficulties of the present time. In two recent issues a writer deals in detail with a Belgian State scheme for granting to a man who has several children a subsidy in proportion to their number, the subsidy to be paid him in addition to his wage or salary. The measure, he says, cannot be upheld in strict justice, for any man, whatever his situation, should be remunerated only according to the amount of work he performs, the difficulties of the work and the special requirements it necessitates on the part of the man in charge being also taken into account. The author points out some of the lengths to which such a scheme may be carried. We cannot follow him in all his arguments. We may, however, note his remarks to the effect that an invalid wife may lead to a greater expenditure in the family budget than two children; two sickly children are, also, generally a greater source of expenditure than four who are in good health. There would be no reason for not allowing lawyers, solicitors, architects, physicians, tradespeople, having a large family, to charge more for their services or their goods than others having no family—but if they did so they would soon be bankrupt, unless fathers of other families were compelled to subsidise them.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—In our issue of May 30 last on page 714 we referred to a lecture by Dr. W. Forbes Leslie, F.G.S., on "The Somerset Oil-Shale Fields" as having been given under the auspices of the Birmingham Branch of the Junior Institution of Petroleum Technologists. We are now informed that the lecture was actually delivered to the Birmingham Branch of the Students Section of the Institution of Petroleum Technologists, and that there is no institution bearing the name "Junior Institution of Petroleum Technologists."

ENGINEERING EXPORTS.

THE exported products of the metal and engineering industries represent about one-quarter of the value of the total exports of all kinds from this country. Table I shows this relative importance, with the percentage of the engineering part of the total exports. The table also shows the variation of this percentage, which was 25 before the war, and has varied from 30 to 22 in the last three years. It shows a falling tendency in the present year, so far as it has gone. While the exports generally are increasing, the engineering products continue to fall. The fall in prices since 1921 has, however, the effect of making the general improvement in export trade appear slower than it really is. Thus, if prices had fallen 10 per cent. per year, the acceleration 70-72-77 in value would be revised to 70-77-92 to express the increase of work done. We do not suggest that this is the rate of falling prices, but merely illustrate the point that to interpret the figures as an increase of employment some revision must be allowed. The total trade of 1913 is to 1923 as 100 is to 150 in value, and if the rise in prices is 50 per cent., the amount of employment is the same; and employment is less if the rise of prices is more.

TABLE I.—*The Value of British Exports of all Kinds; of the Engineering Parts thereof and the Percentage.*

Millions of *l.*

Year. 1	Total Exports. 2	Engineering Exports. 3	Per Cent. 4
1913.. ..	525·25	132·62	25·25
1921.. ..	703·40	217·07	30·86
1922.. ..	719·51	179·84	25·00
1923.. ..	767·33	170·42	22·21
*1924.. ..	783·46	167·88	21·43

* The totals of the first five months expressed as an annual rate.

TABLE II.—*Value of the Five Classes of Engineering Exports forming the Totals in Table I, column* 3.

Millions of *l.*

Year. 1	Steel. 2	N.F. Metals. 3	Implements. 4	Machinery. 5	Vehicles. 6	Total. 7
1913	55·35	12·04	7·13	33·60	24·51	132·62
1921	63·60	11·65	9·00	74·60	58·20	217·07
1922	60·86	11·52	6·43	51·54	49·50	179·84
1923	76·20	14·51	7·41	44·51	27·78	170·42
*1924	78·55	16·48	7·82	42·66	22·38	167·88

* The totals of the first five months expressed as an annual rate.

Note 2. Steel = Iron and steel in pig, plates, sections, &c.

Note 3. N.F. Metals = Non-ferrous metals in ingot, sheets, sections, &c.

Note 4. Implements = Implements, tools, scientific instruments, hardware, and cutlery.

Note 5. Machinery = Engines and electrical and general machines.

Note 6. Vehicles = Ships, road and rail engines, trucks, motor cars and vehicles, cycles, aircraft, &c.

Table II helps to localise the loss, or relative loss, in engineering exports. It consists of the five classes forming the totals in col. 3 of Table I, and shows that the first three follow the rising tendency of total exports—though they fell off slightly in 1922, they recovered fairly well in 1923; whereas machinery and vehicles fell continuously and rapidly when general exports were rising. This may be read as a rising export of metals manufactured to the stage of engineering materials and a falling export of metals fully manufactured for use as machines. Comparing 1922 with 1923, the fall in the engineering total was 9,432,700*l.* but this is the net result of two contrary tendencies which may be stated thus:—

Fall in fully manufactured products, 28,753,261*l.*

Rise in partly manufactured products, 19,320,561*l.*

The fall in machinery is less serious than the fall in ships. It should, however, be considered that shipbuilding has always been subject to more violent fluctuations of activity and that the current revival is not yet due for record as an export. When all allowances are made, there are tendencies towards change in our export trade that should be followed with attention.

INDIAN OVERSEAS TRADE.—H.M. Senior Trade Commissioner in India has forwarded to the Department of Overseas Trade a survey of the import trade of India during the year from April 1, 1923, to March 31, 1924. It states that there has been a steady reduction in the imports into India of machinery and mill-work each year since the boom period of 1919–20 and 1920–21. The past year has seen further heavy liquidations of local engineering firms. The majority of these liquidations have now been made, and it would appear that the figures for the past year show the lowest point in the curve. There has been a slight increase in imports of railway plant and rolling stock, also an increase in those of electrical instruments and apparatus and of motor-cars. The coal imports fell from 882,000 tons to 592,000 tons.

ADVANCED NAVAL BASES.*

By S. F. STAPLES, and Captain D. J. MUNRO, C.M.G., R.N. (Retired).

IN this paper it is proposed to call attention to one aspect of naval warfare, and from this to deduce conclusions as to the direction in which it appears a nation should proceed when taking into consideration the naval requirements of the future. Although strategy is quite outside the ambit of the naval architect, yet once the principles of strategy are made clear either by the teachings of history or by those responsible for the nation's safety, then it is the business of the naval architect to step in and supply the requirements of the fighting forces. Since the introduction of steam there have been only three naval wars fought between nations possessing first-class navies, and in each case early in the war the same step was taken by the more enterprising of the two belligerents—the establishment of an advanced naval base, so that the fleet headquarters might be as convenient as possible to what might be termed the centre of gravity of naval operations. Within due limitations the closer a fleet acts to a belligerent coast-line, the more effective will that fleet be, as it can keep more ships in service. Ships that are detached for repair purposes are of no use to the Commander-in-Chief while they are absent, except as a reserve. Obviously, the shorter distance they have to go for repairs, the shorter time they will be away from the effective fleet. In the second place, while they are detached in this manner, they are very liable to be attacked and damaged; and to protect them during voyage, destroyers have to be detached with them to screen and guard them, with a resultant reduction in the number of destroyers attached to the fleet.

The first of these three wars was between the United States and Spain, when one of the early acts of the United States Navy was to take possession of Guantanamo Bay, on the coast of Cuba, to establish there an advanced base. In the second—namely, the Russo-Japanese War—one of the earliest acts of the Japanese Fleet was to seize, for the same purpose, the Elliot Islands, some 600 miles nearer to Port Arthur than the nearest available Japanese port. The Russians had their base at Port Arthur only partially equipped, and were at a serious disadvantage in not having a dock there. They had a floating crane, and by the aid of this and a Scotch carpenter large caissons were made and lowered over the holes made by Japanese torpedoes; the caissons were pumped out, and repairs made. This, of course, took a very long time, so that the bottoms became foul and the ships could not steam at anything like their normal speed, thus militating greatly against any possible success for the Russian Fleet.

In the world war of 1914-18, notwithstanding the fact that the headquarters of the two principal naval belligerents were within a few hundred miles of one another, still on the British side the same procedure was promptly followed, as to those in charge of operations this course was found to be absolutely necessary. Although the Germans had already an advanced base at Heligoland, it seemed so natural to our naval authorities that they would endeavour to push out a base still closer to the scene of probable activities, that several expeditions were sent out by us for the purpose of locating rumoured bases on the Norwegian coast and among the Scottish islands. In the historical work of Admiral Viscount Jellicoe, *The Grand Fleet* 1914–16, we read on pages 90–1: "It was reported that the Germans had established a base in lat. 62 N. on the Norwegian coast (the exact position unknown)"; and on page 95: "This flotilla (the Fourth) was then detached for operations on the Norwegian coast in conjunction with the Third Cruiser Squadron and the First Light Cruiser Squadron. The latter force was directed to search for a suspected German submarine base in the vicinity of Stavanger Fiord." A few pages further on in the same work (page 107) it is remarked that: "The Sappho was sent to search North Rona Island, a statement having been received indicating that it might possibly have been used by the enemy as a base for aircraft."

During the first two years of the war our Navy established several advanced bases round the coasts of the British Isles, as, owing to Rosyth not being completed, we had no base north of Chatham which was fully equipped to supply the wants of a fleet. It is true that the Tyne had many establishments on its banks fitted with every necessary tool for building and repairing, yet the necessary dry dock accommodation for dealing with damaged battleships was completely lacking. On pages 79–80 of the same book Lord Jellicoe remarks: "In fact, the situation was that, whilst we had shifted our Fleet to the north, all the conveniences for the maintenance of that fleet were still in the Channel ports. The first step was the transference of the large floating dock from Portsmouth to Invergordon, in the Cromarty Firth, together with a staff of dockyard workmen, who were housed in a merchant ship captured from the Germans. Workshops were fitted up on shore under the energetic superintendence of Rear-Admiral Edmund R. Pears and his able staff of dockyard officers. It can be said with great emphasis that this floating dock was simply invaluable to the Grand Fleet. Invergordon gradually developed into a great repairing base. A second and smaller floating dock was purchased early in 1916 at my request and placed there, and by the middle of that year the base had attained large proportions; work of all kinds was carried out with rapidity and success, including the repairs of battleships after the Jutland battle and the great extension in armoured-deck protection fitted to ships after the same action."

Fortunately for the well-being of our naval forces, the Admiralty had a few years before built two floating docks, stationed at Portsmouth and Sheerness, which could lift, even in damaged condition, any and all of the capital ships which then and during the war formed our first line of defence. Accordingly, within a month of the outbreak of war—on August 24, 1914, to be precise—the floating dock at Portsmouth left its moorings for Invergordon, where it arrived on September 6, and on September 9 it was ready to lift its first ship. Of such importance, therefore, was the establishment of an advanced base in the eyes of the naval authorities, that in less than two months from the outbreak of war there was installed ready for work a floating dock capable of dealing with any ship in the Fleet, and forming the nucleus of the advanced base to which the teachings of history seem to point as an essential in modern naval warfare. This dock, with the repair shops which were erected on shore, formed a means of rendering ships seaworthy without the long and dangerous voyage to Chatham or Portsmouth. Later on it was found advisable to install on the Tyne a similar dock to the one at Invergordon, and in August, 1916, the Medway dock was moored off Jarrow, a smaller dock for dealing with destroyers being moved to Scapa. It is thus apparent that as the war progressed the need for advanced naval bases became more and more urgent.

So far only the means of repairing and cleaning ships have been dealt with, but many other things are required at a naval base, and these had to be improvised as the war went on. The advanced base at Invergordon was thus built up of hastily improvised units, and their utility was exceedingly great; but it must be borne in mind that those responsible for collecting the various units together had close at hand the resources of the entire British Isles. Should the next war take place, as may easily be possible, many thousand miles away from these shores, then the difficulties of improvisation will be multiplied enormously. In the light of these historical facts which have been briefly summarised, it would appear logical to arrange that any future naval headquarters should be to a great extent mobile, instead of being built ashore and thus immovable, so that on the outbreak of hostilities everything essential may be ready for instant removal to whatever advanced base the General Staff may decide upon as most advantageous for the occasion which has arisen, and much valuable time will thus be saved.

Having now established on historical grounds the necessity for the advanced naval base, attention is naturally directed to the consideration of what special items a Commander-in-Chief would desire this base to contain. As speed is one of the essential features of modern warfare, the provision of a floating dock would first and foremost be called for, in order that ships' bottoms may be kept clean, even if it were not required for the more important duties of repairs after action. If by rapid repairs a ship can be kept afloat, she can still fight, even if half her guns be gone, and as long as she remains afloat she has some potential value, but if sunk or beached she becomes at once useless. A floating dock to be used in the circumstances we are now considering would have to be specially built for the purpose, as none are in existence that fulfil the required conditions. The Portsmouth and Medway docks being now too small to accommodate our largest class of battleships, we have to consider what should be the size of the dock. This question is largely answered by the conditions of the Treaty of Washington, but we also have to take the Hood into consideration. The Hood, of 41,200 tons' displacement, is the sole representative of her class. By the Washington agreement all future vessels are to be kept down to 35,000 tons; they are presumably, therefore, shorter than the Hood, which, by the way, is scheduled to be scrapped in 1941. Should we legislate for this vessel, or for the new 35,000-ton battleships only, always bearing in mind that the smaller we can make our dock the more easily and rapidly can it be transferred from the permanent to the advanced base? It would appear that a suitable compromise would be to design a dock especially for the 35,000-ton battleship of the present and near future but just capable of lifting the Hood. As the straight keel of the Hood is about 770 ft. long, the lifting portion of the dock need be but little more than this. The clear width of entrance of such a dock should be about 120 ft. More width could be given, entailing a slight amount of extra steel in the hull, if draught of water at its anchorage is a consideration, since the wider the dock the shallower the pontoons for equal lifting power. But bearing in mind that a mobile dock would have to be towed long distances, there are many advantages in keeping its beam down as much as possible. The draught of water over the blocks of a dock capable of lifting battleships in normal trim should be about 33 ft.; but during the late war the Lion struggled home into the Tyne drawing 39 ft. by the head. Commander C. N. Robinson, writing in *Brassey's Naval Annual*, 1924, states that modern vessels when damaged might draw as much as 45 ft. It would appear, therefore, that a modern dock should have, at normal working stresses, a draught over blocks of about 35 ft., but with sufficient freeboard to enable it to be sunk in case of urgent necessity to give 42 ft. of water over the blocks. It may also be noted here that as a floating dock has no sill, the 4 ft. 6 in. keel blocks, if necessary, might be kept down to 18 in., and thus give, without in any way affecting the dock's structure, the postulated 45 ft.

But a repairing base requires more than a dock; it wants also complete workshops and accommodation for the workmen and personnel. To turn first to the workshops, these in a floating base may be either on the dock itself, or may be in the form of a separate floating workshop. For general convenience the workshops on the dock itself are the better. As the size of the fleet using the advanced base will be large, it would probably be better to have both, as many repairs will have to be done upon ships which may not be in need of docking. The floating workshop should be about 400 ft. long, with a beam of 90 ft., having three decks and a flat roof. It should be capable of dealing with heavier repairs than could be undertaken in the dock workshops. The hold would be taken up by a foundry and store-room, the first deck by large machine tools, the second deck by light machine tools and drawing-office, and the top deck would contain living accommodation for 500 men and officers. The roof would be utilised for recreation.

When the Portsmouth and Medway docks were being designed it was required to arrange for workshops inside the walls, but although a good many tools were installed in these, the accommodation was necessarily cramped, as the width of the walls was only 13 ft., and from that has to be deducted the depth of the frames. Moreover, it is difficult to allow for sufficient openings in the top deck without unduly weakening the same. In the tropics, too, such workshops would be unpleasantly hot to work in. A better means of attaining the same end is to outrig considerably the top deck of the walls, and place the machinery there under a roof. This was done to some extent on a dock belonging to the Brazilian Government, and workshops with a floor area of about 5,000 sq. ft. were built. In the case now under consideration it is proposed still further to develop this idea, and Figs. 1 to 5, on page 838, show a dock with such workshops. The ultimate size of these shops must, of course, depend upon a variety of circumstances outside the scope of this paper; but it might be pointed out that if the top decks of a dock 700 ft. long be outrigged to the extent of 30 ft. rather over an acre of available workshop space will be obtained. The greater part of this would be roofed over, but open spaces would be provided so that material loaded on trollies in the workshops could be run along to the nearest open space, and be picked up by one of the dock's cranes and deposited on the ship or dock's deck.

To provide an equivalent to "quay space," which is always of value, there should be pontoons moored on each side of the dock. This is not an essential part of the scheme, but would be found probably of great convenience. In order to save the men's time in going to and fro, mess accommodation would be arranged on the dock, but sleeping quarters would better be found on a separate craft. The dock we have been describing should also be supplemented by a smaller one for the purpose of dealing with destroyers and small cruisers. In connection with the floating docks, a mooring lighter would have to be provided of sufficient size to take 600 tons of cables on board. This would be sent on ahead of the dock when the base was being moved, so that the moorings would be ready when the dock arrived. Another important item would be a floating crane, capable of dealing with the heaviest weight on board a battleship, such as the low-pressure turbine. The jib of this crane should be able to plumb the centre line of the ship when in dock. This crane would be transported on the deck of the dock when the base was being moved. This was done when the Portsmouth dock was towed to Invergordon. It is not proposed to describe in detail other units of an advanced base, as in nearly all cases existing tonnage could be adapted for the purpose.

* Paper read at the Joint Summer Meeting of the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders, London, on Wednesday, June 25, 1924.

FLOATING DOCK FOR ADVANCED NAVAL BASES.

Fig. 1.

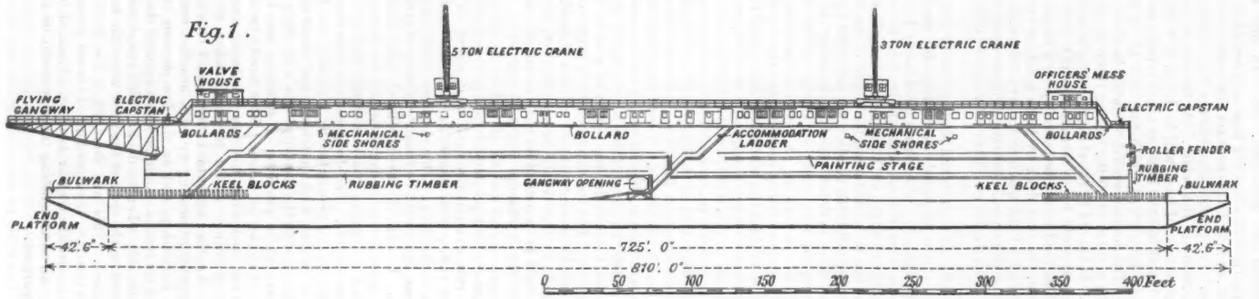


Fig. 2.

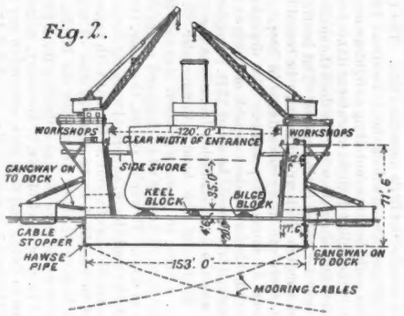


Fig. 3.

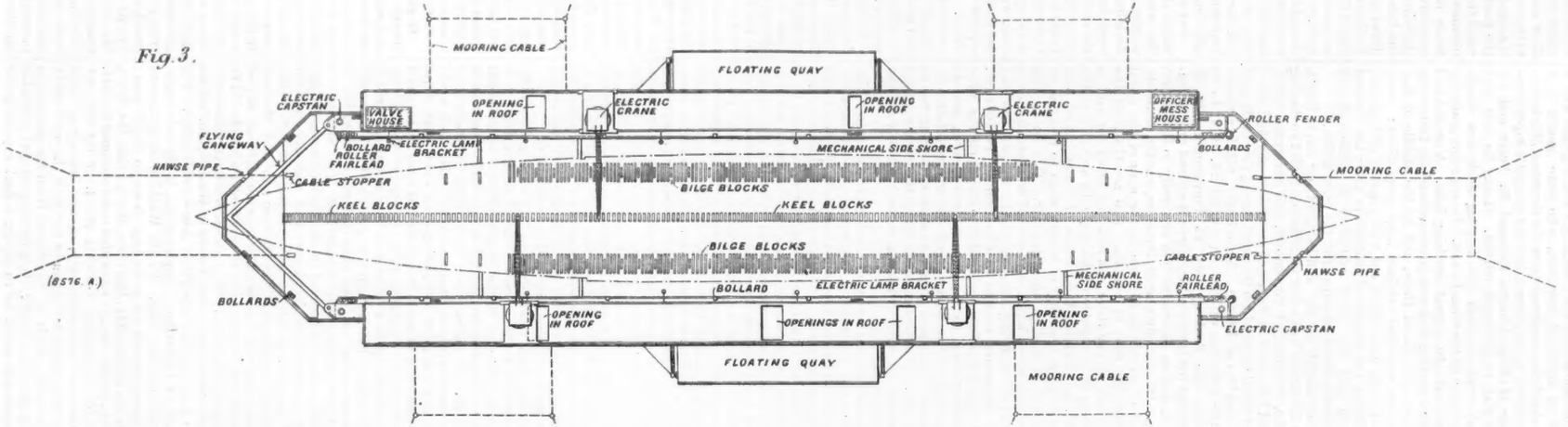
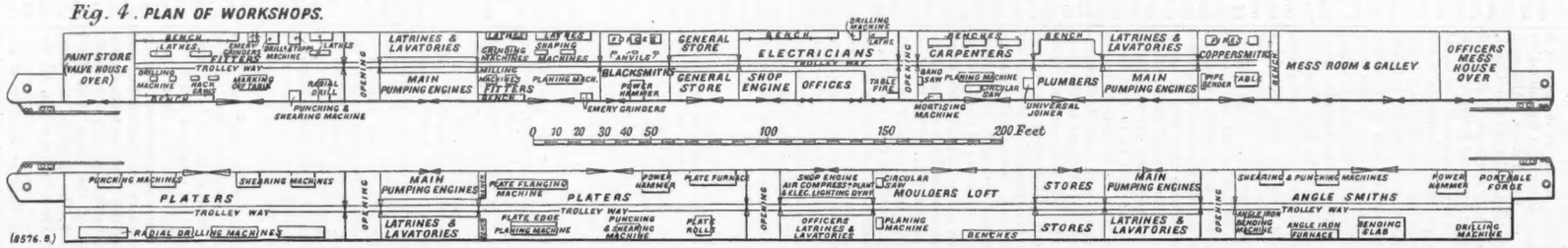


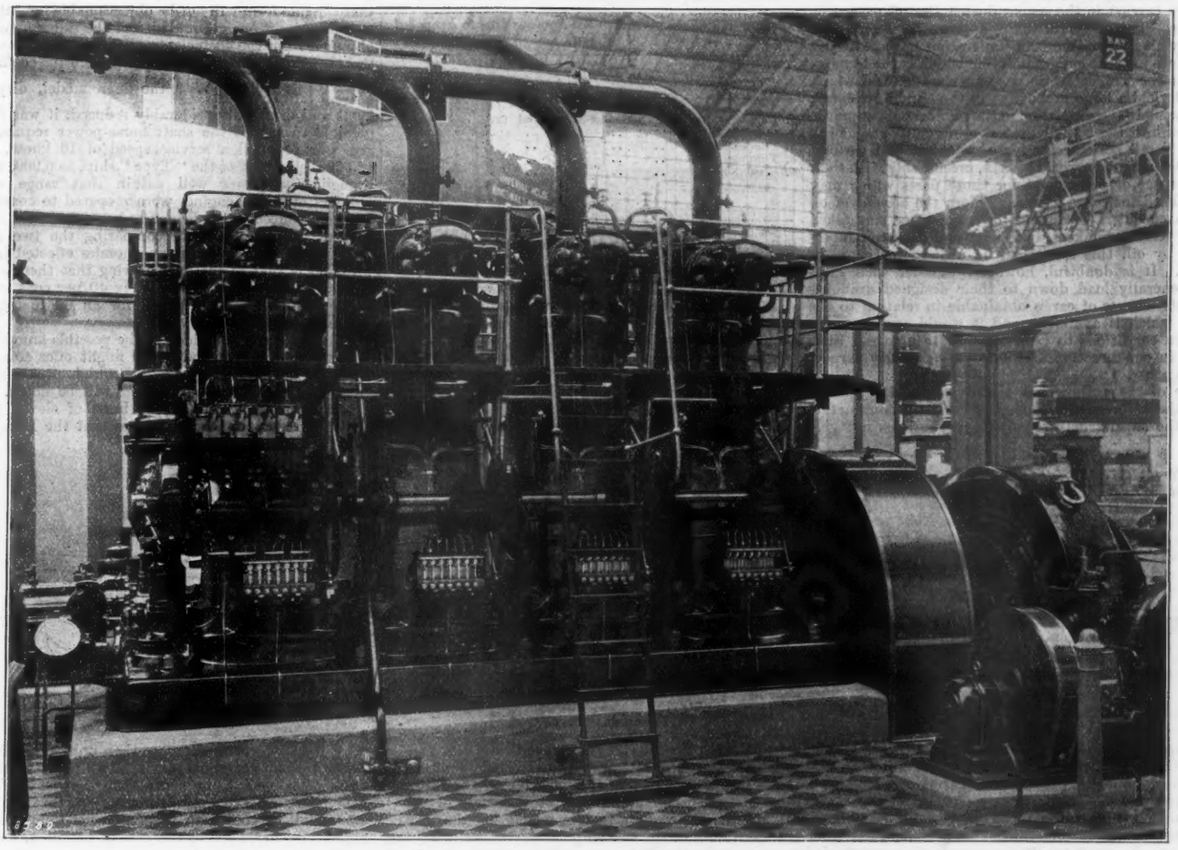
Fig. 4. PLAN OF WORKSHOPS.



We managed during the first year of the war to get together a very efficient floating base at Invergordon, in spite of the great shortage of ships of all sorts from which we then suffered and the difficulty of finding sufficient labour to convert them. It should be much easier now, with the experience we have gained, to select the required bottoms from the large number we have laid up, and convert those of them most suitable into units for our new floating base. The first cost of a mobile floating base would be very considerably less than that of a permanent land construction. A large proportion of the units that would form such a floating base we already possess, and we still have plenty of ships doomed to be scrapped that could easily and cheaply be converted to such purposes. A dock such as has just been decribed and illustrated would cost approximately 500,000*l*, which is not a large sum when one considers its immense value in time of war. It is an unfortunate fact that docks do not appeal to the imagination as do battleships. The nation more or less cheerfully spends five or six millions upon the building of a Hood, and yet will require a considerable amount of persuasion to devote one-tenth of this sum upon a means of keeping the Hood and the rest of the battle fleet in fighting order. Many of the tools with which the dock would be equipped should be available already in our dockyards. The great restriction in the number of ships that make up our present Navy, owing to the Washington agreement, must leave us with many of our existing dockyards overstocked with tools, stores, and the other items that are required in an arsenal. Further, the addition of the bulge to our capital ships, thus increasing their beam considerably, has had the effect of making the existing oversea dockyards at Gibraltar, Malta, and Simon's Bay of far less value than formerly as repairing bases for these ships, as the dry dock entrances there are too narrow to admit them in a badly damaged condition. They, therefore, also should be in a position to supply some of their now partly superfluous plant.

Taking into consideration only those items which would have to be built specially for the purpose, it is considered that a floating base could be fitted out at the cost given in the table which follows :—

RUSTON-CROMPTON GENERATING SET AT THE BRITISH EMPIRE EXHIBITION.



	£
Large floating dock	500,000
Small floating dock	50,000
Floating crane	200,000
Floating factory	500,000
Mooring lighter	50,000
Launches, &c.	100,000
	1,400,000

or, say, one and a-half million pounds. With this establishment at hand and ready, a base could be rapidly fitted up that would meet the requirements of a fleet operating at a great distance from a fixed base, and so enable a Commander-in-Chief to push his attack close to the enemy's coast-line.

In the light of the facts set forth in this paper, should we not ask ourselves if we as a nation would be doing the right thing if we were to install at Singapore or elsewhere a permanent base on shore, with excavated dry docks, that will take years to complete and cost a large sum of money, the greater portion of which will be spent abroad? Should we not rather provide, at a vastly less cost, the whole of which would be spent in British labour, a floating base fully equipped, which in time of war or threat of war could be bodily and readily transferred to whatever port or base the general staff might deem the best for carrying out its duties.

RUSTON-CROMPTON GENERATING SET AT THE BRITISH EMPIRE EXHIBITION.

THE whole of the supply of alternating current required at the British Empire Exhibition is obtained jointly from the the mains of the North Metropolitan Power Company and from the turbo-generators in the Exhibition power-station, which we have described and illustrated fully in previous issues. Such direct current as is needed is furnished partly by rotary converters and partly by engine-driven generators on the stands of various manufacturers. One of the firms contributing in this respect is Messrs. Ruston and Hornsby, Limited, of Lincoln, who show the oil-engine illustrated in the view above, as a working exhibit. This engine is of the four-cylinder open type, with airless injection of the fuel. The cylinders are 18-in. bore by 22 in. stroke, and will develop 420 brake horse-power when the engine is running at 250 r.p.m. The fuel oil, which may be of the lowest grade obtainable, is injected into the combustion space by a pump, no compressed air being used, the compression in the cylinder being sufficient to ensure instantaneous ignition and combustion. A separate pump is used for each cylinder. The inlet and exhaust valves are operated by separate eccentrics in conjunction with rolling levers, the latter being cased in, and lubricated by oil under pressure. The valves are horizontal and are fitted in cages within the cylinder heads. No trouble has been experienced with the horizontal valves, which have now stood the test of work for long periods, and have shown themselves fully as reliable as when arranged vertically.

Each fuel pump can be adjusted separately to time the injection for its own cylinder, so as to produce the best indicator diagram. The setting having once been made, requires no alteration unless some new fuel of a very different quality is used. Governing is effected by by-passing a greater or less proportion of the oil pumped, back to the service oil tank. It is possible to put any individual pumps out of action if desired, and all four can be instantly cut out in case of emergency. The starting and operation of engines of the type illustrated are independent of any hot bulb, heated surface, or ignition device. They are set in motion by compressed air, and begin to fire as soon as the fuel is turned on. They will start with any kind of fuel which is not too viscous to flow at low temperatures. When very heavy oil, such as furnace oil with a specific gravity of 0·95, is used for fuel, a lighter oil is used for starting until the heavier oil has become sufficiently warmed by the exhaust heater.

The engine at the Exhibition is direct-coupled to a dynamo, manufactured by Messrs. Crompton and Co., Limited, of Chelmsford, delivering current into the three-wire network at 440 volts across the outers, the machine running in parallel with the rotaries and other direct-current generators serving the same system. Engines of a similar type are built in sizes to develop from 250 to 825 brake horse-power. They are all tested to 10 per cent. above their rated power, and in every case the customer is supplied with a certificate of the fuel consumption and power developed. Under working conditions the consumption is guaranteed not to exceed 0·42 lb. per brake-horse-power hour.

PASSENGER SHIP DESIGN FROM AN INDEPENDENT POINT OF VIEW.*

By JOHN ANDERSON and ROBERT STEELE, B.Sc.

WITHIN recent years several papers of outstanding interest on the subject of passenger ship design have been read before this and other kindred Institutions, and the discussions on these papers, coupled with recent traffic developments and the many improvements which have been made in ship equipment, &c., have prompted the authors to suggest a view which they hope will merit discussion. At the outset it is desirable that we should make it clear that our remarks are directed principally toward the intermediate speed class of vessels designed primarily for passenger service across the Atlantic, but it is also thought that our views might be applicable to liners on the Australian and Pacific runs, considering that it is desirable to reduce the number of fuelling stations to a minimum. The post-war era clearly demonstrated the popularity of the intermediate type of liner, as shown by the tonnage of that class in service to-day; and, in order that our views may be readily understood, it is necessary to follow and analyse the steps taken during the development and progress of this type of vessel since it began to assume such an important part in the liner world of to-day. The late Mr. Peskett read a paper before the Institution of Naval Architects in 1913 which gave a remarkably good guide in this respect, and a study of the figures given by him, taken in conjunction with plans and other information published since, shows how the percentage volumes allocated for machinery, fuel, stores, fresh water, and more particularly passengers, have increased, whilst that available for cargo has been steadily reduced.

* Paper read at the Joint Summer Meeting of the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, and the North East Coast Institution of Engineers and Shipbuilders in London, on Wednesday, June 25, 1924.

Present-day ships are designed to carry passengers from a deck which is well below the designed load-line to the top of their high superstructures, although in many cases the lower 'tween deck accommodation has been arranged to be portable in order that cargo may be carried in the spaces during the off-passenger seasons. This class of ship appears to have been heavily hit by the American Emigration Laws, catering as it does for that emigrant traffic which is the foundation of the Transatlantic passenger trade, and which should yield a large proportion of the annual revenue; but, owing to the restriction in the numbers of emigrants allowed into the United States, other employment has to be found periodically for such ships, and we find them being sent on world cruises, presumably with their cargo-space empty except for those parts which may be utilised for extra stores. Before the advent of oil fuel, a considerable amount of cargo-space was taken up by reserve bunkers, but since coal has been superseded by oil, this space can be utilised for cargo or stores. It is doubtful, however, whether such ships can generally load down to their designed draughts with the classes of cargo obtainable in relation to the space which is available, and it would appear under modern conditions to be customary to obtain a little cargo in one direction and only part capacity cargoes in the other.

One of the authors has already stated his opinion that the enforced disposition of cargo in conjunction with the superstructures now in vogue does not give a proper balance in stability between the light and load conditions, and it might also be said that any design which makes provision for carrying cargo affects the trim and the most suitable position of the centre of buoyancy from the point of view of economical propulsion. It is sometimes found that when these ships are designed to obtain even keel in the loaded condition with cargo, the trim is as much as 10 ft. by the stern when light, which is very undesirable from the point of view of docking, since it involves the use of considerable quantities of water ballast, thereby increasing the mean draught. The matter of arranging hatchways, winches, derricks, &c., to work the cargo in such vessels has been complicated in recent years on account of the problem of arranging boats and life-saving appliances for all, under the new regulations, and also of placing watertight bulkheads so that the best system of subdivision is obtainable. There is no doubt also that the hatchways and other cargo equipment have increased the difficulty of arranging entrances, berthing, &c., for the passengers accommodated on the lower decks, also that serious loss of time is involved in the lifting or lowering of cargo from the holds to the tops of the trunk-ways, tending to increase the time required to "turn round," and so decrease the number of voyages per annum. These difficulties caused us to consider whether or not conditions had now reached such a stage of development as to make cargo-carrying unprofitable in this class of vessel, and, if such were the case, to determine the best lines to work along in order to design a more economical ship to suit present-day requirements.

TABLE I.—*Showing Comparison between Proposed Vessel and an Existing Liner.*

Item.	Proposed Vessel.	"Type" Vessel.
1. Length	550 ft. 0 in.	550 ft. 0 in.
2. Breadth	68 ft. 9 in.	70 ft. 0 in.
3. Moulded depth	35 ft. 9 in.	42 ft. 9 in.
4. Load draught	20 ft. 8 in.	28 ft. 10 in.
5. Weight of vessel (tons)	10,200	12,560
6. Fuel for 20 days (tons)	590	2,810
7. Fresh water for 10 days (tons)	600	1,300
8. Stores for 10 days (tons)	250	250
9. Passengers and baggage (tons)	350	350
10. Cargo (tons)	Nil	5,960
11. Load displacement (tons)	12,050	23,230
12. Block coefficient	0·54	0·73
13. Service speed (knots)	16	16
14. Shaft horse-power	6,900	12,500
15. Type of machinery	Diesel	D.R. geared turbines.
16. Initial cost (approx.)	526,000*l.*	560,000*l.*
17. Gross register tonnage	11,800	16,365
18. Net register tonnage	7,300	9,877
19. Number of 1st class passengers	235	235
20. Number of 2nd class passengers	355	355
21. Number of 3rd class passengers	1,256	1,256
22. Crew	344	360

TABLE II.—*Estimated Annual Savings Due to Proposed Vessel.*

Item.	Amount.
	£
1. Depreciation, insurance and repairs at one-seventh initial cost	4,850
2. Fuel saving	78,400
3. Tonnage dues	5,670
4. Crew	2,480
Total	91,400

Net freight rate required by "Type" ship to obtain the above savings, assuming full deadweight cargoes both ways

$$= \frac{91{,}400l. \times 20s.}{5{,}960 \times 11 \times 2} = 13s.\ 11d.$$

In our initial investigations we assumed that the machinery would be double-reduction geared turbines, which is the type of machinery generally installed in present-day vessels of this class. The results, although seeming to show a considerable improvement over the "Type" ship, did not indicate economies to the extent which we expected.

On substituting oil engines for geared turbines the results were considerably improved, and, as will be shown later, very clearly demonstrated what seems to be the superiority of the former over the latter as the best means of propulsion for this class of vessel. It may be stated here that in estimating the relative initial values of the two ships a very liberal allowance was made for the high cost per horse-power of internal-combustion engines. The results of our investigations are indicated in Tables I, II and III, and show a comparison between our proposal and a typical ship recently built which is representative of the class generally employed on the transatlantic service to-day.

TABLE III—*Showing Comparison of Stability of Proposed Vessel and an Existing Liner.*

Conditions.	Proposed T.S. Passenger Ship.	"Type" Ship, Passenger and Cargo.
	G.M.	G.M.
1. Light ship	+ 2·70 ft.	+ 1·70 ft.
2. Departure condition:— With full complement of passengers, baggage, fuel, water and stores, and cargo in the case of the "Type" ship	+ 3·20 ft.	+ 3·70 ft.
3. Arrival condition:— Fuel, water, stores, &c., consumed, and water ballast added	+ 2·40 ft.	+ 1·30 ft.

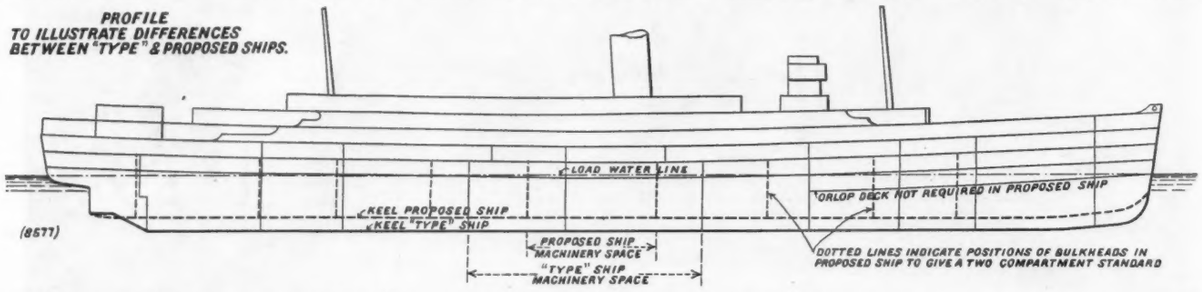
It will be seen that our proposal is, compared with the "Type" ship, to reduce the depth by 7 ft. 9 in., and this, in conjunction with a reduced breadth of 1 ft. 3 in. and a much finer model, which results from a number of considerations, permits of a considerable reduction in weight of hull, while the tonnage measurement will be greatly reduced. It would also be permissible to dispense with the orlop deck forward on account of the reduced depth; the freeboard will be precisely the same in both ships. Furthermore, the lighter vessel, reduced fuel, lower power, and absence of cargo, permit of designing the vessel with a block coefficient of 0·54 on a draught of 20 ft. 8 in.; and the reduced block coefficient and displacement enable us to obtain the speed with only 55 per cent. of the power required for the "Type" ship. The space required for machinery in the "Type" ship can be reduced in our proposal in length by about 50 ft. by fitting oil engines. With the absence of hatchways, except that to baggage hold, and by making the total length of super-erections the same in both vessels, we find it possible to carry at least the same complement of passengers as in the "Type" ship, even allowing for the finer lower decks of the resulting model, while the airing space on deck will be increased.

It might be explained that the form which we have under consideration has been specially prepared to give exceptionally full body above water, in order that the fine form will not be objectionable for Atlantic weather conditions. Some idea of the fullness may be obtained from the coefficients at the 28 ft. water-line: the area coefficient is 0·79, and the inertia coefficient $\left(\frac{\text{Inertia}}{\text{Area}^2}\right)$ is 0·616. With the finer model, displacement and draught considerably reduced, it was found possible to reduce the shaft horse-power required to give our proposal a service speed of 16 knots, from 12,500, being that of the "Type" ship, to 6,900, which brought the power well within that range which builders of Diesel engines were prepared to construct, and the reduced power helped to bring down the initial cost of the machinery in comparing the two ships. One of the most important economies effected in our proposal is that in fuel, considering that there are oil engines consuming approximately 40 per cent. of the fuel per horse-power required for an oil fuel geared turbine installation.

Table II gives some idea of the possible annual savings which the proposed vessel might offer compared with the "Type" ship, and the high proportion of these due to the reduced fuel bill will be noted. The calculations are made on the basis of eleven round voyages per annum, and assumes that the Diesel fuel oil will cost 20 per cent. more than ordinary boiler oil. These estimated annual savings, which total 91,000*l.* make it necessary, in order that the "Type" ship may prove an economical proposition, that she must secure full cargoes both ways at a net freight rate of about 14*s.*, exclusive of the cost of handling, management, &c., which might amount to an additional 6*s.* per ton. This is the most optimistic view which can be put forward for the "Type" ship, but it is very doubtful if full deadweight cargoes could always be stowed in such a ship, assuming it were possible to obtain them. Under present-day conditions it seems more probable that the ship's maximum lift with a full complement of passengers would be not more than 3,000 tons in one direction, and generally little or none in the other; such loads would necessitate a *net* freight rate of about 48*s.*, and it is improbable that such an average rate could be obtained.

Table III shows a comparison of the stability of the two ships, from which it will be seen that there is a much more uniform measure of stability in our proposal, and the design lessens considerably the variation in the metacentric height between the light and load conditions. Regarding trim, another important factor which is embodied in the non-cargo-carrying vessel is that both in the departure and arrival or light conditions the ship is practically on an even keel. The profile drawing of the "Type" ship gives an idea of the modifications which would be made, including the subdivision (shown dotted), which would make our proposal a two-compartment standard ship under the ordinary assumptions.

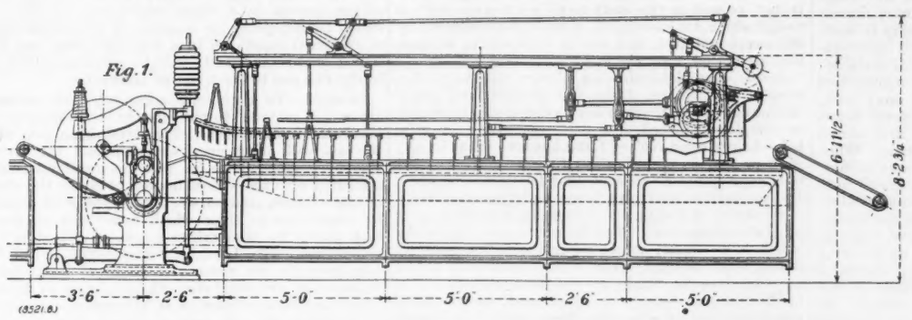
In conclusion, we realise that deductions such as ours are largely dependent upon the variations of expenditure associated with such proposals, and our object is simply to raise this question in order to induce discussion on what might be a development of some importance, particularly in the case of vessels having speed-length ratios greater than that which we have illustrated.

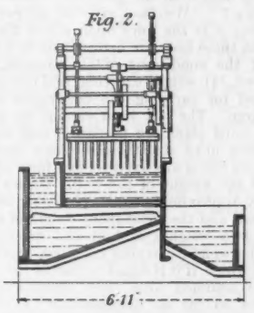

PROFILE
TO ILLUSTRATE DIFFERENCES
BETWEEN "TYPE" & PROPOSED SHIPS.
LOAD WATER LINE
ORLOP DECK NOT REQUIRED IN PROPOSED SHIP
KEEL PROPOSED SHIP
KEEL "TYPE" SHIP
(8577)
PROPOSED SHIP MACHINERY SPACE
"TYPE" SHIP MACHINERY SPACE
DOTTED LINES INDICATE POSITIONS OF BULKHEADS IN PROPOSED SHIP TO GIVE A TWO COMPARTMENT STANDARD

GERMAN ACTIVITY IN SOUTH AFRICA.—According to *The South African Mining and Engineering Journal*, a party of gentlemen, representatives of German iron and steel magnates, have been touring the Waterberg and Rustenburg districts in search of iron ore. One of the most recent places they have visited is the Boshoff Range in the Rustenburg district, and approximately 30 miles from Rooiberg in the Waterberg district. It is stated that these gentlemen were very satisfied with the result of their investigations. What further move will be made is uncertain, as these hills are at present about 70 miles away from the nearest railway.

WOOL WASHING MACHINE AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS HUGHES AND LANCASTER, LIMITED, ENGINEERS, RUABON, WALES.





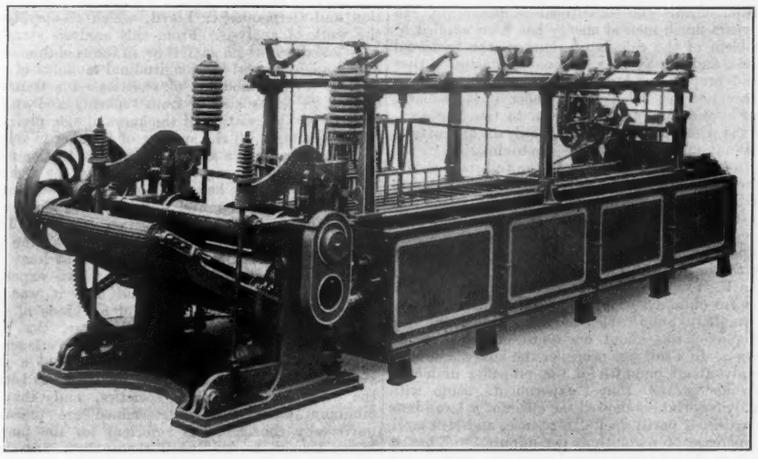


FIG. 3.

WOOL WASHING MACHINE.

In early days wool was washed by the process of moving it, to and fro, in a trough containing a cleansing solution. This was a manual process, the operation being performed with long forks by men who stood at the side of the trough. When mechanical working was introduced it was natural that the designs followed the old process and made use of forks. Later the "harrow" type of machine superseded this method and has since retained its popularity—despite the introduction of other methods. The accompanying illustrations show a machine of the "harrow" type, manufactured by Messrs. Hughes and Lancaster, Limited, of Acrefair Engineering Works, Ruabon, North Wales, which is exhibited in the Palace of Engineering of the British Empire Exhibition. Figs. 1 and 2 show an elevation and section while a general view is given in Fig. 3. These illustrations are of a single machine, but usually the equipment is built up of four machines through which the material passes in turn. The general arrangement may be clearly understood from a consideration of a particular case. If 1,500 lb. of wool are to be washed per hour, the first washing trough would be of about 33 ft. length. After treatment in this unit the wool would be passed through a pair of spring-loaded squeezing rollers to remove the excess moisture and with it much of the dirt. The wool would then be passed to the second bath of about 25 ft. length and be put through a similar process and afterwards would enter the third machine of about 20 ft. length, and then pass to the fourth unit, which would be still smaller, actually about 15 ft. in length. Between each stage rollers are always used to remove excess of solution and the suspended dirt it carries with it. At the end of the process the wool will be found free from dirt and grease. The average change of weight due to the removal of foreign matter is about 50 per cent. In exceptional cases the loss may amount to as much as 75 per cent.

Each machine is filled with water heated to certain temperatures, a common practice being to keep the temperature in the first machine about 130 deg. F., and have a drop of 10 deg. F. from machine to machine. Although this is common, it must not be taken as a hard and fast rule, because users frequently adopt other temperature conditions which they consider suit their work better. Alkali, commonly in the form of carbonate of soda, and soap are added to the baths. The alkali solution is made up in separate tanks and added to the troughs as required. The fourth bath is generally used as a rinsing machine. In every case the action that takes place is the same. The wool is fed in at one end of the machine, which has a main frame extending nearly the full length of the trough. This is moved up and down as well as backwards and forwards by motion obtained from eccentrics on a cross shaft. On this frame are several rows of prongs. When the frame moves downwards the prong tips force the wool into the solution and carry it along about 10 to 12 in. The prongs then rise, come clear of the liquor and go back to the initial position, and this action is continued. At the delivery end in addition to the main frame there is an auxiliary one which is actuated similarly but completely out of phase with it. The length of stroke of each frame may be varied at will to suit the work. This is a considerable advantage, as different classes of material have frequently to be treated. The liquor freed from the material by passage through the rollers is conveyed to a side settling tank (see Fig. 2), where the grease rises to the top and the dirt settles at the bottom. The liquor containing the salts dissolved out of the wool is pumped back into the main bowl to play a part in the scouring of the wool. After passage through the rolls the wool is taken by an endless belt type of conveyor to the next machine.

The improvements shown in the design of this machine are to be found in the means of actuating the frames, which are arranged to permit of adjustment, and the use of an auxiliary delivery frame which may be adjusted to deal with all the various classes of wool.

POWER HOUSE AUXILIARIES.—We have received from Messrs. Mather and Platt, Limited, Park Works, Manchester, an attractively illustrated brochure commemorating their work in power house auxiliaries at Barton and at other great power stations. Their work in condenser, boiler feed and extraction pumps is dealt with, together with electrical auxiliaries from motors to rotary converters. A copy of this publication will be sent to all responsible engineers who are interested.

SHIP DESIGN.*

By Sir JOHN BILES, K.C.I.E., LL.D., D.Sc.

THE Institution of Naval Architects is the senior society of its type, and its history is coincident with that of the iron age of shipbuilding—an age which has made possible the great increase in size of ships, from the 200-ft. ship of the wooden age to the 900-ft. ship of to-day, from the 2,000-ton wood ship of the earlier time to the 60,000-ton steel ship now crossing the ocean. A justification for the founding of the Institution, if any be necessary, is that so many others in this and other countries have been founded and continuously carried on, and that their work has been of such a high order of merit that in order to be fully informed of the progress of the art and science of naval architecture one must be familiar with the work of all these institutions. The object of them all must be the contribution they can make to the successful designing of ships which shall each be better than those that have gone before.

What is the design of a ship? To this question many answers may be given. We are all familiar with the contributions, small and large, which many men make to the success of a design. To answer the question we must be clear as to what is the design of a ship. For warships we have a Director of Naval Construction, who is responsible to the Board of the Admiralty for the design. In merchant ships which are bought ready made, there is no doubt that the shipbuilder is responsible for the design, but in many ships of commerce, which are made to order, the shipbuilder's claim is not so undoubted. Sometimes the ships are built to carefully prepared plans and specifications produced by the shipowner or his representatives, but even in these cases conditions of speed, stability, and weight-carrying are usually imposed upon the builder which make it necessary for him to investigate the problem of the design in exactly the same way as if no indication had been given of the owner's requirements except such as could be contained on a "half-sheet of notepaper."

The influence of the Institution of Naval Architects and of the Admiralty in course of time helped to produce trained naval architects whose knowledge of the strength, resistance, and stability of ships was such that the best forms of the minimum weight could be produced with a fair degree of certainty, and both shipbuilders and shipowners have taken advantage of the services of these men to create improved types of ships. The question of design became something more real. Designs were produced more from first principles than from small departures from previous examples. The general adoption of progressive speed trials gave the naval architect the chance to determine what was the relative value of different forms of hull and dimensions of propellers. The continuous accumulation of tank data and the publication of results reduced the chances of error, until at the beginning of this century there was little excuse for the non-fulfilment of predicted speed conditions. In the earlier days of the tank work the results related mostly to fine forms, but, later, similar results were obtained for the fuller forms, so that all classes of ships could be designed with more certainty. Even in the earlier days, when tank results were only available to the favoured few, some strikingly successful results were obtained. One of these was that of an Atlantic liner which, with the same type of machinery, rivalled the existing holder of the speed record for a consumption of fuel of only two-thirds of that of the older ship.

* Paper, abridged, read at the Joint Summer Meeting of the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders, in London, on Wednesday, June 25, 1924.

Such results are not likely to be got now, but, in the National Physical Laboratory and in other tanks, results are being achieved to-day in which improvements for special conditions are being obtained which amply repay the cost of the experiments.

Let us deal with the question, "What is the design of a ship?" We may give an approximate answer by saying it is the lines upon which the ship is built, and that these lines are determined by a full consideration of the conditions of (1) strength, (2) stability, (3) speed, (4) weight-carrying, and (5) accommodation provided for carrying the passengers (if any), crew, and cargo. The last item cannot be properly determined until plans are prepared, and the first cannot be known until structural sections are made. When these two items are fixed we can form an approximate idea of the weight of the hull. On an assumed form we may approximate to the power required to produce the speed and the consequent weight of the machinery. These two weights of hull and machinery, together with the weight-carrying required, make up the total weight which, if it is equal to that of the water displaced by the assumed form, will afford a solution of our problem so far as displacement is concerned. We must then review this result to see if the required stability is obtained. An experienced naval architect will make a successful approximation to these results, but if he fails he does not call in the assistance of the experienced sailor or other sea-going official, or anyone else, but modifies his approximation until it is correct, and thus he is the man who determines the form of the ship. Others can take a part in planning the accommodation for passengers, crew, and cargo—a very important part, but not that which enables any one of them justly to say that he designed the ship. Perhaps for our purpose a general answer to the question, "What is a ship design?" may be given in these terms: Ship design is the preparation of plans from which a seaworthy ship can be built to fulfil stated requirements as to weight-carrying ability and capacity, stability, strength, speed, and accommodation for passengers and crew. This statement of ship design really covers the whole field of operation in designing and drawing offices; but in practice it is sometimes restricted to cover only the preparation of the "key" plans which, evolved by the aid of accumulated experience, determine all the others. The sheer draught (or lines) is obviously a key plan, affecting weight-carrying, stability, and speed. The midship section is also a key plan, governing the structural strength. The general arrangement is also a key plan, having a direct effect on all the stated requirements except speed. The preparation of these key plans only does not necessarily constitute a successful design. For example, the main structural arrangements indicated on a midship section may be adequate, and yet the completed ship may show signs of weakness due to purely local causes. These local causes may, and often do, result from imperfectly considered details of the general or structural arrangement. Again, sanitary, culinary, and cargo-handling arrangements have an important bearing on the general arrangement; and yet such matters are frequently left to be worked out as the ship is under construction, sometimes with undesirable effects which might have been avoided had more consideration been given to them in the making of the key plans. The originator of an arrangement plan, midship section, and lines does not necessarily complete the design; he can be said to be a master naval architect only if in the preparation of the key plans he has accurately in imagination the limitations imposed by constructional items not shown in the key drawings, and also the limitations imposed by many other items such as sanitary and cargo-handling arrangements.

If this answer to the question of "What is a ship design?" be broadly accepted, it will be seen that a considerable variation in the practice of preparing a design is possible. The custom of inviting tenders from several shipbuilders at the same time tends to minimize the amount of work done on the design until such time as the particular shipbuilder who is to build the ship is determined. The shipowner is usually protected in the specification, or by agreement in having reserved to him or his representatives the right to approve of the plans and details of construction, but the work of preparing these drawings for his approval is usually that of the shipbuilder. To produce the best result the shipowner, through his representatives, should be fully competent efficiently to superintend the design and construction of the ship, and it need hardly be said that to be fully competent to carry out this work the superintendence should be that of a fully trained and experienced naval architect, assisted by some of the staff of the shipowner who have experience in the running of ships. The part in which these last named are of greatest assistance in the early stages of preparing the design, is in the development of the arrangement plan. It will probably be conceded that all matters concerned directly with arrangement of accommodation are non-scientific; such details as come under discussion may be the occasion for a display of adequate knowledge, but are not as a rule the occasion for scientific treatment. We may therefore look upon the arrangements as the work of the craftsman or artist rather than that of the scientist. It may be well at this state to review the elements of design which are susceptible of scientific treatment by the naval architect, and see to what extent reliance may be placed upon them.

Speed.—The determination of the resistance of a form is an instance of scientific method, and yet it can hardly be said that our knowledge of ship resistance is complete. Indeed, the fact that the successful behaviour of some evolved forms has been unexpectedly good or bad is an indication that we have not yet fully appreciated the elements that determine resistance. By imagination we evolve forms, and by measurement of resistance of models we try to decide the efficiency or otherwise of the form. But the resistance of the model which is accurately measured is a complex quantity which must be split up into its constituents before any use can be made of the measurement. The method of calculating one constituent, the frictional resistance, and treating the other main constituents as the residue of the total involves a double error if the calculation of this one constituent is inaccurate. In recent years much mental energy has been applied to the problem of the calculated element, the frictional resistance, and it may be a reasonable conclusion that form and proportions have an effect on this element which are not yet calculable. Hence it is probable that our application of science, even to the consideration of the resistance of a model is only an approximation. What may, then, be the approximation in the twenty to forty-fold expansion to the full-sized ship.

The resistance element is only a part of the problem of speed. There is the propulsion element, which also is an instance of scientific method, in the determination of the qualities of a model screw, and also an instance of a gap to be bridged in the application of the model results to the full-sized ship. Consider, for example, Mr. R. E. Froude's standardized propeller results. These were obtained with propellers having bosses to "the smallest practicable diameter" (actually the boss diameter was about one-tenth of the propeller diameter). In a full-size propeller the boss diameter is commonly about one-fifth of the propeller diameter. Mr. Froude stated that "experiments made with ordinarily large bosses showed the effect of a large boss to be material, partly in its resistance, and still more in an increase of revolutions per minute."* Thus it would seem that a knowledge of the effect on propeller qualities of variation in boss diameter is essential before Froude's standardized propeller curves can be applied with certainty. There is a further disconcerting element in the Froude standardized propeller results, inasmuch as they are based on an artificial "analysis pitch" involving the use of a correction factor whose constancy has already been a subject of discussion in the Institution of Naval Architects. The mere fact that the correction factor as used by Froude is lower than any of the ratios of analysis pitch to face pitch for his model screws is an indication that our knowledge of the subject is not complete.

Bearing in mind the possibility of error in the determination of effective horse-power from tank results, it is not surprising that there should be difficulty in distributing the elements for power over the range between effective horse-power and indicated, or shaft horse-power, without the use of a correcting factor such as the so-called "relative rotative efficiency." It is unfortunate that this term has been adopted in circumstances where its validity is questionable. There are several instances of its application as the result of analysis whose accuracy is doubtful on account of the above-mentioned considerations. There is, however, still another possible source of error in expanding model propeller results, namely, a possibility of a failure in the law of comparison. One investigator has stated, although details of his experiments are lacking, that he failed to establish correspondence between model and full-size propeller experments.† Admiral Taylor records a slight decrease in proportionate thrust capabilities in passing from a 6-in. propeller to a similar 24-in. propeller.‡ If there is a measurable decrease in thrust capability in expanding from 6 in. to 24 in., how much is the decrease in expanding, say, to 16 ft.? These considerations indicate the gaps that must be filled up before our knowledge of the speed element in ship design becomes truly complete. They indicate also the importance, from the design point of view, of careful analysis of trial trip data in the direction of distributing the various power elements over the range between measured horse-power and effective horse-power. An attempt at such an analysis is given in the Appendix for a ship whose model resistance and trial data are known, from which it will be seen that a gap in our knowledge still exists. Consideration is being given at the present by a committee of the Institution of Naval Architects to the question of the determination of frictional resistance in a full-sized ship, and it is hoped that some results will be obtained which will bridge this gap in our scientific knowledge.

Strength.—To determine accurately the necessary amount of material to put into the structure of a ship involves a full knowledge of the straining action which the sea will bring upon the ship and the stresses thereby produced. So far, it is not possible to obtain a strictly scientific determination of either the strains or the stresses, and so we have to be guided partly by experience in ships which have been on service and partly by comparison based on scientific considerations. The Load-Line Committee of 1913–15 laid down for the purpose of freeboard assignment a standard of structural strength in relation to draught. This standard was based on an exhaustive examination of requirements of various classification societies, *i.e.*, Lloyd's Register, Bureau Veritas, British Corporation and Germanischer Lloyd, which co-operated in the work of analysis. From this analysis standards were laid down which gave these in terms of dimensions and draught for (*a*) the longitudinal modulus of resistance; (*b*) the modulus of resistance for transverse frames, in terms also of frame spacing and span of frame; (*c*) the relation of thickness of side plating to frame spacing; (*d*) the spacing of framing in relation to dimensions. The work of the 1913–15 Committee has not yet been accepted officially by the Board of Trade, but it has been embodied in the Japanese freeboard regulations, and it is expected that it will shortly be adopted by the British Board of Trade. It is stated that it is already embodied as the basis for structural scantlings in the rules of at least three of the classification societies from whose experience the standards were derived, and that it was used during the war for the design of all kinds of naval auxiliaries. It may be said, therefore, that as a result of this work and subsequent experience the code of requirements for the scantlings of a ship's structure has been practically standardised as between the various classification societies, and that the minimum scantlings so determined are practically universally considered as sufficient for the purposes of sea transport. But while the analysis was carried out in a scientific manner, it was based entirely on the tabulated requirements of registry societies, and was not an investigation based on first principles. It ignored the large question of the effectiveness of the various elements of the ship structure in resistance to flexure. This fundamental question is only gradually being brought to the foreground of the problems deserving consideration; but until it is dealt with fully there will be a large gap in our scientific treatment of structural strength.

The consideration of the straining action on the structure of a ship due to local inequality of weight and buoyancy extends back over nearly two centuries, although the systematic determination of shearing forces and bending moments, by substantially the same methods as are employed to-day, began only in the early years of the Institution of Naval Architects, about 60 years ago; the chief development in method since then is that use is now made of machines for measuring the areas under the various curves plotted in the course of the calculations. Incidentally, it does not seem to be fully realised that there are very great advantages to be derived from the use of both integraph and integrator in strength calculations, the integraph for completing the shearing force, bending moments, and deflection curves after the curves of weight and buoyancy have been checked as regards areas and centres of areas by means of the integrator. When the method of determining shearing force and bending-moment curves was established, it did not seem to be completely appreciated that the results had not an absolute value, for it took some time before the necessity of adopting a standard wave-length in relation to ship length and standard conditions of loading were adopted. The fact that results can only have a comparative value makes it essential that the comparisons should start from a common or standard basis.

The present-day bases of comparison are, for sea-going ships, (*a*) as regards the waves, wave-length equal to ship length and height equal to one-twentieth of the length; and (*b*) as regards loading, it is assumed that there is a full load of homogeneous cargo filling all cargo spaces, and that the consumables—fuel, fresh water and stores—are in or out according as they give a maximum straining action in the assumed conditions. If water ballast is necessary to give stability or trim in either of the standard conditions,

* Trans. I.N.A., vol. l.

† See Discussion on Admiral Taylor's paper "Model Basin Gleanings." Transactions of American Society of Naval Architects and Marine Engineers, 1906.

‡ Tansactions of American Society of Naval Architects and Marine Engineers, 1906.

it is assumed to be disposed where it will have the maximum effect on the bending moment.

The consideration of the stresses in the structure of a ship lagged far behind the earlier consideration of the straining action on the structure. Fairbairn's investigation, published in the first volume of the Transactions, of the Institution of Naval Architects, seems to be the earliest within the knowledge of naval architects. This investigation was based on the use of the "beam" formula :—

$$W = \frac{a\,d\,c}{L}$$

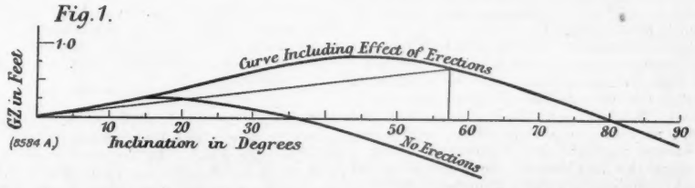
where a = area of material in deck and for 6 ft. down the sides.
d = effective depth of girder; this is really the "lever arm" of the internal couple, the distance between the centre of the "pull" or "push" force in the deck, and the centre of the "push" or "pull" force in the bottom.
c = a constant.
L = length of ship.
W = permissible load.

This formula may be written :—

$$\frac{W\,L}{C_1} = p \times a\,d$$

if c is replaced by $(C_1 p)$. Then $\frac{W\,L}{C_1}$ represents the bending or external moment (usually now called M), and $(p \times ad)$ represents the moment of the stress, or internal moment (usually now written as $\frac{p\,I}{y}$) where p represents the stress per unit of area of the material.

Fig. 1.



The external and internal moment must necessarily be equal so that the formula is correct on principle.

At the date of Fairbairn's investigation there was a tendency to restrict the quantity of iron in the upper regions of ship structures, so that the structures were not well designed to resist hogging moments. To this improper practice Fairbairn directed attention, and his views are expressed in these words : "Hitherto I have contended for equal sections at the top and bottom, but cases may arise where stronger bottoms are necessary, as in screw steamers which take the ground, but in other cases the nearer the deck and bottom approach each other in sectional area the better."* This historical digression serves to illustrate the slowness with which a true scientific idea may permeate practice. Thirty years after Fairbairn's investigation many ships were built with the heavy material disposed at the second deck down rather than at the top deck. In 1872 there was published in the Transactions of this Institution a complete calculation for the longitudinal "modulus of resistance," or $\frac{I}{y}$, of a midship section, with deductions for rivet holes and with the wood deck considered in terms of its equivalent area of iron. There has been no development from that calculation, although since the beginning of the century there has been more recognition of the fact that the modulus of resistance is a factor of importance in all strength problems.

Before our consideration of the strength element in design can be said to be truly scientific, we must make an attempt to fill in the gap between calculated results and actual experience. That there is such a gap is apparent from the fact that ships have been designed on the basis of such a high allowable working stress as 10 tons per square inch in the upperworks when in the hogging condition, and yet have been found amply strong. The filling-in must, however, be done from both the sides of straining and that of stress. There must be more investigations of the stresses actually existing in the structures of ships at sea; some experiments have been made in this connection, notably the Wolf experiments in this country. Professor Suyehiro is making an investigation on some ships trading in the Pacific. The Wolf experiments,† made in dry dock, provided for that ship a complete knowledge of the longitudinal stresses produced by known straining actions and also an assurance that the basis of our strength calculations is sound, but the subsequent trial at sea indicated clearly that there is a gap in our knowledge of the straining actions on a ship, for the stresses registered in heavy weather were considerably less than the calculated stresses under standard conditions which the ship had successfully withstood in dry dock. The filling-in of the gap from the calculation side involves a reconsideration of our basic assumptions. For example, the fact that it is customary to adopt stress figures which increase with size of ship implies that the standard assumptions for the determination of bending moment become unduly severe as the size of ship increases. This may be in part due to excessive wave-height in relation to length, it having been generally observed that long waves are not so steep as short waves. It may be in part due also to an excessive severity of the assumptions as regards loading. The standard conditions may be possible, but they are not frequently probable, and perhaps Sir Westcott Abell may offer us a better standard involving the "odds on" for the possible.*

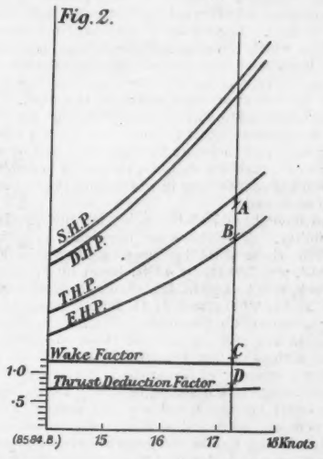
The method of determining the modulus of resistance of the ship structure also deserves consideration. It has already been noted that there has been no development in this matter during the fifty years since the calculation was introduced. There has been, however, a considerable extension of the practical quantitative knowledge of the modulus of resistance expressed in the work of the Load-Line Committee to which reference has already been made. The Committee laid down a standard of modulus in relation to draught, but this standard hardly comes into the category of scientific accuracy.

The gaps in our scientific consideration of transverse strength and local strength are much wider than those in our consideration of longitudinal structural strength. There is, it is true, the scientific analysis of registry society requirements for framing embodied in the Load-Line Committee's Report, and this provides valuable absolute information as to reasonable moduli of resistance for framing. It also forms a basis for comparison of framing which is not in accordance with registry society practice. But here again the treatment was not based on strictly scientific principles, for the inter-relation of frame and floor stiffness was not directly taken into account. For the practicable scientific consideration of transverse strength it seems necessary to adopt the principle of least work as applied by Dr. Bruhn; but before the method can be most usefully employed it will be necessary to adopt standard conditions of loading. Perhaps the registry society representatives can offer suggestions as to what those standard conditions should be. As regards the consideration of local strength, there is no scientific treatment, although valuable papers on particular aspects are contained in the Transactions of the Institution of Naval Architects. A penalty attaching to our ignorance of the local strength consideration is that defects that are purely local may be attributed to general structural causes, with consequent general additions to scantlings which may be totally unnecessary. The possibility of such a consequence of inadequate knowledge brings into relief the importance of adequate knowledge for the purpose of diagnosis; accurate diagnosis of defects is a condition precedent to economic design. For a full knowledge of stresses we must have a full knowledge of the straining action caused by the motion given to the ship by the sea. On definite reasonable assumptions the straining actions caused by pitching have been determined, but probably the greatest increase above the statical strains is caused by shipping water at the fore end of a ship. While those who go to sea are familiar with this increase, there does not seem to have been any definite attempt to calculate this straining action. The stresses due to rolling are also not well known. All these gaps in our knowledge are provided for in the general practice as to scantlings which is embodied in the classification societies' rules, but there is room for further scientific investigation.

Stability.—Stability is one of the elements of naval architecture which seems to admit of more exact determination than those already dealt with, but it is not wholly susceptible of exact determination. That idea of stability, which is measured by the righting arm of the couple tending to cause the ship to return to the upright or move further from it, is dependent on the relative position of the centre of buoyancy and the centre of gravity. It is well known that it is possible to determine accurately the locus of the centre of buoyancy for any constant displacement for all directions and angles of inclination, whether longitudinal, transverse or other direction of inclination. It is also possible to determine this locus for all displacements. The work involved in this, which to the pioneers in it was a great labour, is very much reduced by means of the integrator and integraph. It is possible to reduce it still further if these curves be standardised by the method indicated in the paper I read on "The Standardisation of Ship Calculations" before the Institution of Naval Architects in 1901.* This method has not been generally adopted, and so for the present more work is found for the naval architect than otherwise would be. To some this is not an unmixed disadvantage.

The other end of the arm of the righting lever is determined by the position of the centre of gravity of the ship. This can be accurately determined by inclining the ship when completed. The position so determined is made use of for ship-designing purposes. The exact determination of the centre of gravity of a proposed ship must either be obtained by complete calculation of all the weights of the ship, which involves much detail work, or by approximate calculations based on the known position of the centre of gravity in an existing ship. The operation of making detailed calculations is very laborious, and its reliability depends on the exact knowledge of numerous details and their weight in the ship not yet designed, and upon the accuracy of the calculator's work. In most cases

Fig. 2.



it is the practice to rely on experience in previous ships rather than to make detailed calculations. The success of this method depends on the judgment of the calculator, and has been known to lead to considerable errors. In all calculations of this kind there must be a "personal equation" which, if known, can be used with great advantage. I am of the opinion that the most reliable method is to take a somewhat similar existing ship whose centre of gravity is known, and with the full knowledge of the weights and their position in the ship make a calculation with a view to finding the position of the centre of gravity of the existing ship. The difference between the actual known position found in the existing ship and that determined by calculation will give the "personal equation" of the calculator. If this same calculator be set to work out the position of centre of gravity by the same detailed method of calculation and his "personal equation" be applied, we may expect to get an accurate result. This is very laborious, and may be only justifiable in cases of costly vessels and where the knowledge of the exact amount of stability is of great importance. There are other methods in use which vary in the degree of their accuracy somewhat in relation to the labour spent on attaining results. It has been suggested that less time be spent in drawing offices on pretty accommodation plans and more on laborious calculations, but who is to determine the relative value of incommensurable things?

With a full knowledge of the position of the centre of gravity of the ship and of the centre of buoyancy in all positions of inclination, we may construct what is known as a curve of stability for each condition of loading and draught. We have solved the problem

* Trans. I.N.A., vol. i.
† Trans. I.N.A. vol. xlvii (Part I), page 80.

* Trans. I.N.A., vol. lxii, page 223.

* Trans. I.N.A., vol. xliii, page 327.

of how much stability a ship has, but we have to answer the question: How much stability should a ship have in order that she should be satisfactory in working and safe at sea? In a paper read in 1922* an attempt was made by me to compare stability under wind pressure of recent large ships having very high sides, with older ships of lower sides, and it was there shown by exact calculation that the later vessel has as good a reserve of safety as the earlier ones which had been crossing the Atlantic for many years. This is only one element for which stability is to be provided. The other is that of being able to resist the action of the sea which causes a ship to roll, so that she shall not roll sufficiently to use up all her stability. So far as we can determine theoretically, it is certain that large angles are experienced only in cases of synchronism between the period of the ship and impulse of the wave. Confirmation has been secured by experiments on models and observations on ships of what had previously been ascertained mathematically, namely, that the period of rolling of a ship increases with increase of radius of gyration and decrease of the metacentric height. The longer the period, the better chance a ship has of avoiding synchronism and consequent rolling, because long-period waves are long and are scarcer than short ones, but it is not possible to determine the ship's period that is necessary on the basis of maximum observed lengths of waves. The determining factor is governed by the speed of the ship and the angle of encounter to the crest of the wave. It is therefore evident that the object of the naval architect should be to give a ship the smallest amount of stability in the upright condition that is consistent with the convenient working of the ship in and out of port, and sufficient to enable her to resist any probable wind pressure which would give her an inconvenient angle of heel. The curve of stability for the worst condition which the ship is likely to encounter at sea should have such an area that the dynamical stability represented by it is sufficient to absorb all the energy caused by rolling and the action of the wind. There is enough information available and enough knowledge of method to enable this to be worked out for any particular ship, and therefore the answer to the question, "How much stability should a ship have in order that she should be satisfactory in working and safe at sea?" can be answered.

Ships have been lost through the undoubted want of stability. The following is a case in point:—The ship whose stability curve is shown in Fig. 1, page 843, was 340 ft. by 45 ft. beam by 27 ft. to the spar deck, and had poop, bridge, and forecastle respectively 30 ft., 90 ft., and 27 ft. long. She was laden with grain in bulk in the holds and in bags in the bridge and poop, the end openings of these erections being closed with shifting boards. During very heavy weather a steering chain broke and the ship fell off into the trough of the waves, capsizing before relieving tackle could be rigged and a course made. The fact that there was no record of a list prior to the disaster, and that feeding trunks and grain boards were arranged in accordance with Board of Trade Regulations, makes it unlikely that the cargo had shifted. The stability curve is based on an estimate of the condition of loading at the time of the disaster. The upper curve gives full credit for all the erections; the lower curve takes account only of the ship up to the spar deck. Hence the true curve lies somewhere between the two curves shown. The stability curve was obviously inadequate, as the ship capsized, but it does not follow that both the G.M. (and therefore the initial slope) and the range here shown are generally inadequate for this size of ship. Initial slope and range should be related inversely, so that high-freeboard ships may be considered satisfactory with smaller metacentric heights than low freeboard ships, which is consistent with a standard stability obtained by determining the amount of dynamical stability required to absorb the upsetting energy of the wind and sea. The maximum amount of dynamical stability available may be compared with that which is satisfactory in existing ships, remembering that there is discomfort in excess of metacentric height as well as in defect of it, and there is danger to life and limb of passengers in excessive rolling. The answer to the question of how much stability is required will be given, therefore, partly as the result of calculations and partly on the judgment and experience of the designer.

Safety at Sea.—Safety at sea against the action of the wind and sea on an intact well-designed ship, with ample sea room, depends on the strength and stability of the ship, about which nothing further need now be said. The necessary apparatus or safe navigation at sea does not give much trouble to the ship designer. Little, if anything, can be done in the design to prevent collisions at sea, but the risk of loss of life and ship may be minimised by boat equipment and subdivision, which provisions are amply provided for by the present Board of Trade requirements. The working out of the boat arrangements in accordance with these requirements in large passenger ships has presented difficulties which have been claimed to be insurmountable if the arrangement of boats is to be one which will permit of the whole of the life-saving equipment being launched in a suitably small time. The difficulty arises from the fact that the possible available appliances such as davits or cranes are too few and too slow in action to allow all the boats carried to be launched in the suitably small time. Proposals have been made to replace the rear rank of boats, which would have to wait their turn for launching, by rafts which could either be thrown overboard or would float off when the ship sank. The relative value of these two schemes depends on what is a suitably small time in which the operation must be carried out. That time must depend on the nature of the accident and the ability of the ship to behave so as not to prevent the satisfactory launching of the boats, &c., for that time. Bilging by striking rocks or ice, collision with another ship, and fire, are amongst the causes which may make the ship behave prejudicially to satisfactory and sufficiently quick boat launching.

Subdivision.—Subdivision of the ship into fire and watertight compartments is the means of obtaining sufficient time to launch boats. If the subdivision is sufficient, the necessity for launching boats is generally non-existent. Subdivision and boat arrangements cost money and may reduce profit, and in consequence are not always popular with shipowners. After a disaster sympathy is given to the passengers, but when there is no disaster ringing in our ears our sympathies may go out to the poor shipowner who is deprived of profit to provide security which is so seldom needed. This is the political side of ship design which may be discussed on a proper occasion, but not by me at the end of this paper. I think, however, it may be said with some confidence that the application of our knowledge of the subdivision and boat-handling question is of a high order of accuracy, and that when the proper authorities tell the naval architect what are their requirements in these subjects they may confidently rely on the information which he is now able to give. The question has received international consideration, and the final results of the long deliberations are looked forward to with great interest.

Machinery.—It is obvious that no ship design can be complete without satisfactory machinery design; but while the naval architect must necessarily be very familiar with the latest developments of engines and boilers, he relies completely on the engineer for these designs and their adaptation to the ship. The Institution of Naval Architects has in the past and will in the future offer a field for full discussion of all developments in propulsive machinery.

APPENDIX.

Fig. 2, page 843, is an attempt to analyse the elements which go to make the difference between E.H.P. and S.H.P., the former as derived in the tank, and the latter as derived on trial trip. These two curves are shown as the upper and lower curves in the diagram. To obtain the power delivered at the propeller by the shaft we have to deduct the loss in transmission on account of the friction of bearings. The power delivered has been taken at from 94 per cent at the lowest speed shown (14 knots) to 97 per cent. at the highest speed. The results are shown in the curve marked D.H.P. The next lower curve, that marked T.H.P., has been determined from the D.H.P. by the use of Froude's standardised propeller curves. On the base of analysis slip ratio a curve of D.H.P. for the propeller was plotted, this D.H.P. curve being obtained from Froude's expression:—

$$\text{T.H.P.} = \text{B}\,\frac{p^5 \times 21}{p}\,\text{D}^2\,\text{V}_a^3\,y \qquad . \quad (1)$$

Applying the results of this T.H.P. curve to the curve of efficiency, we get a D.H.P. curve.

In the equation (1), B, p, and D are known; y varies with the analysis pitch and has the values given by Froude; and V_a can be calculated by the known speed of a ship and the assumed "analysis of pitch."

If now we plot on the same basis of analysis slip the curves of propeller efficiency, we shall be able to find that propeller efficiency at which there is equality between the D.H.P. which can be absorbed by the propeller and the D.H.P. delivered by the shafting. Plotting these corresponding propeller efficiencies to a base of speed of ship, we can obtain a curve of T.H.P. It should be noted that the "analysis pitch" used in the evaluation of T.H.P. from Froude's expression has been taken at 1·099 × face pitch, this being the relation between the two quantities given by a consideration of Froude's published figures of analysis pitches for his model screws and Professor T. B. Abell's statement of the face pitches. From the analysis slips at which the values of D.H.P. absorbed by the propeller equals the value of D.H.P. delivered by the shafting, the real slips, *i.e.*, the slips based on face pitch, were determined, and thence the curve of wake factor, $\frac{v}{\text{V}_a}$. From the curves of E.H.P. and T.H.P. the curve of thrust-deduction factor, $\frac{\text{R}}{\text{T}}$, was determined,

In a case where data are available from experiments with propeller and model in combination, the relative rotative efficiency can be estimated. In this particular case it was found to be 0·965 at 17¼ knots. Hence the ratio $\frac{\text{T.H.P.}}{\text{D.H.P.}}$ at 17¼ knots enables us to get T.H.P. at that speed. This is shown at A. If the hull efficiency is determined by model experiments we can determine the T.H.P. In this case it was as determined, and the point B shows the value of T.H.P. so found. The distance between the points A and B indicates a gap in our scientific knowledge of about 9½ per cent. of the S.H.P. The wake factor and thrust deduction factor determined from the model experiments are indicated respectively by the points C and D near the wake factor and thrust-deduction curves.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—The Minutes of Proceedings No. 8 of this Institution, which have just been issued, contain full abstracts of a paper by Capt. R. N. Liptrot on "Three-Ply and Its Uses in Aircraft Construction" and of a paper on "The Soaring Flight Question," by Dr. E. H. Hankin. The papers were read at meetings of the Institution held on October 23 and November 9, 1923, respectively, and reports of the discussions at these meetings are also printed. The proceedings are obtainable from the offices of the Institution at 60, Chancery-lane, W.C. 2, the price per copy being 1*s.* 6*d.*

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* Trans. I.N.A., vol. lxiv, page 325.

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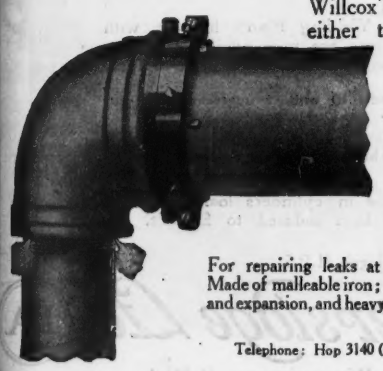

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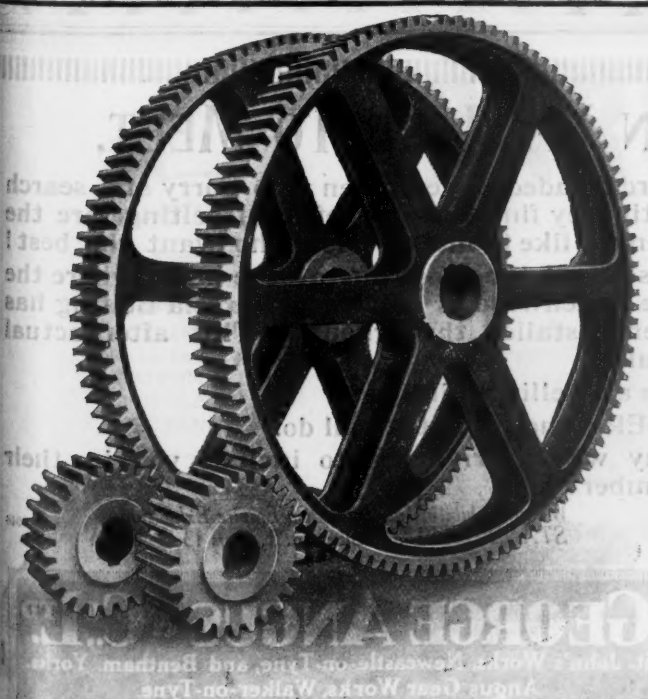

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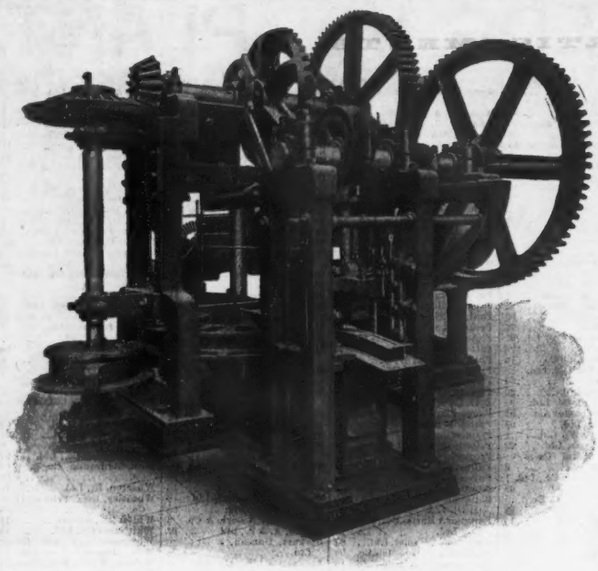

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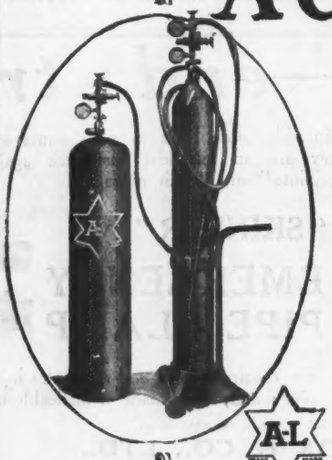

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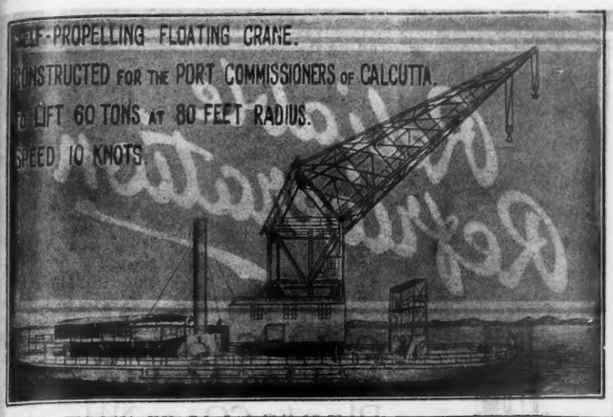
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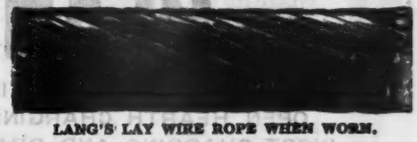

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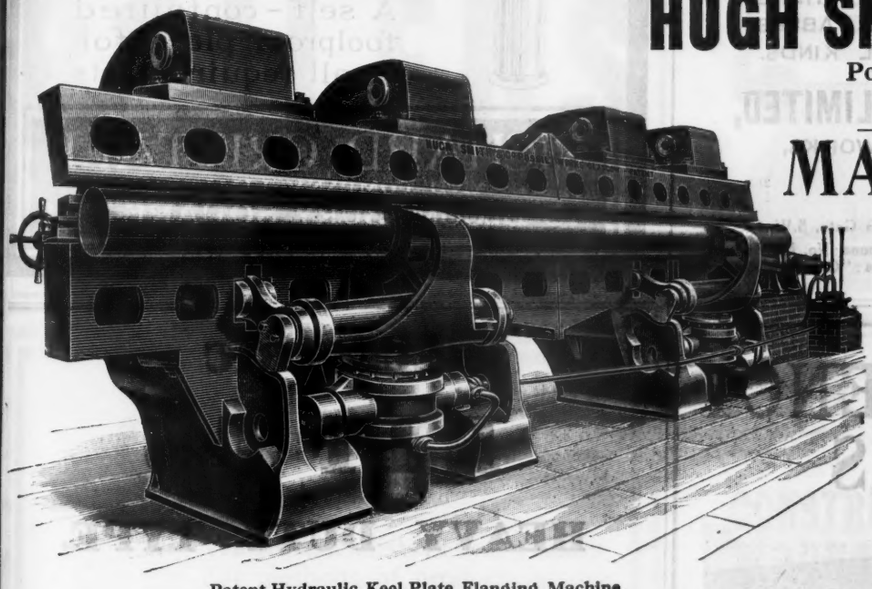

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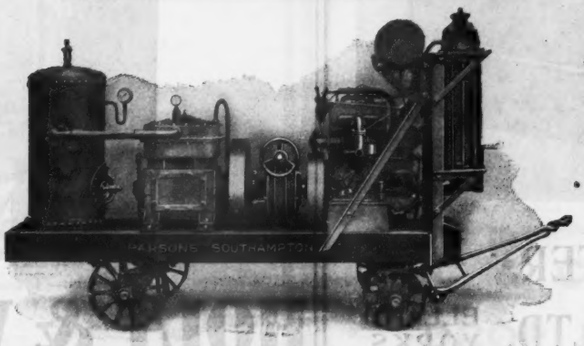

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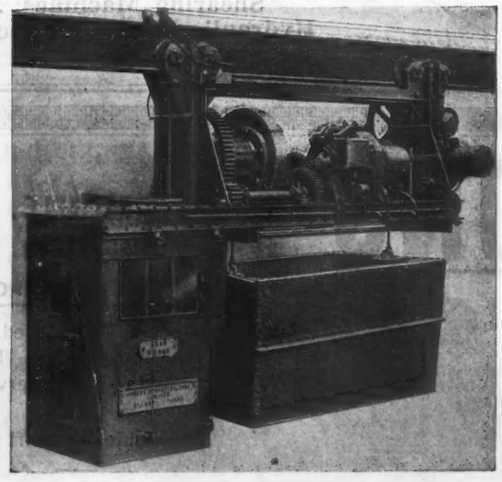

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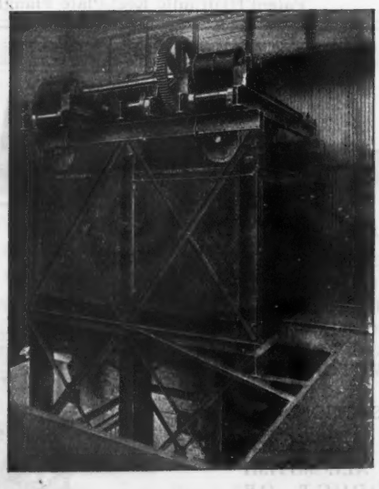

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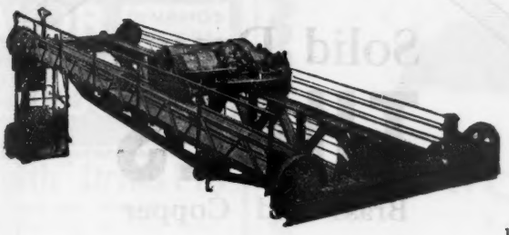

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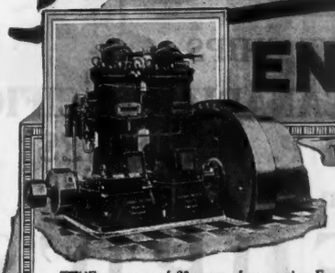

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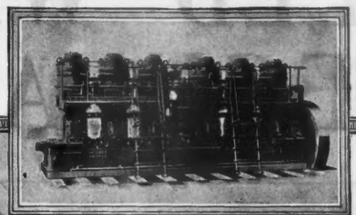

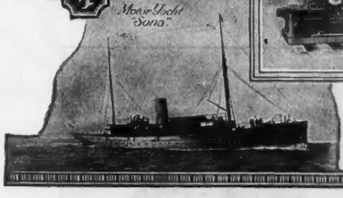

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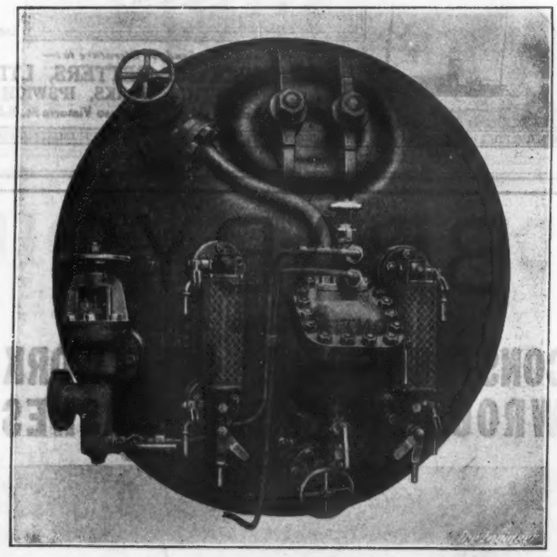

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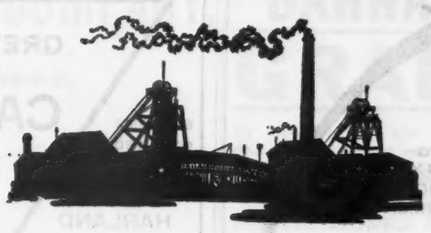

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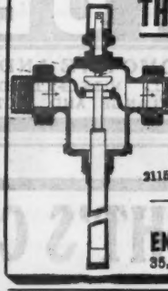
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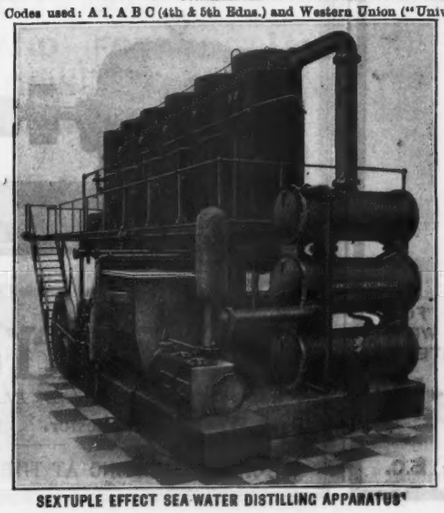
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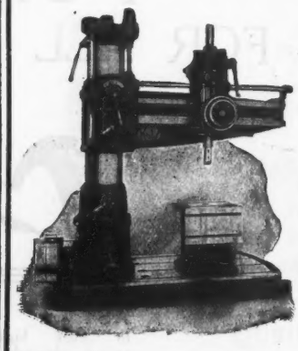
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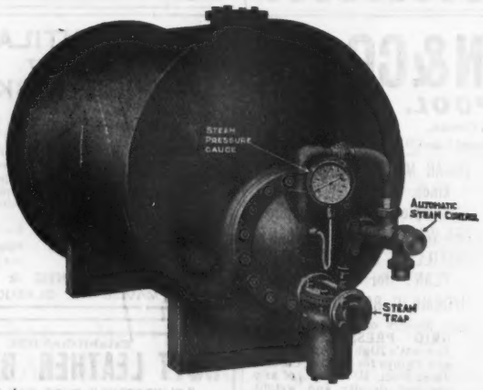

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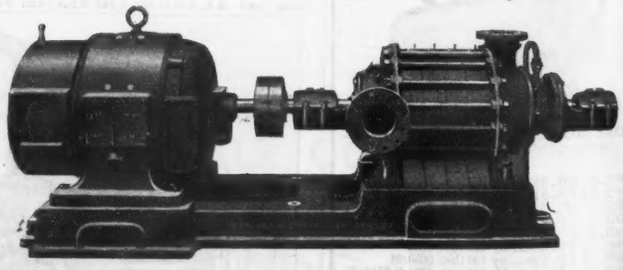
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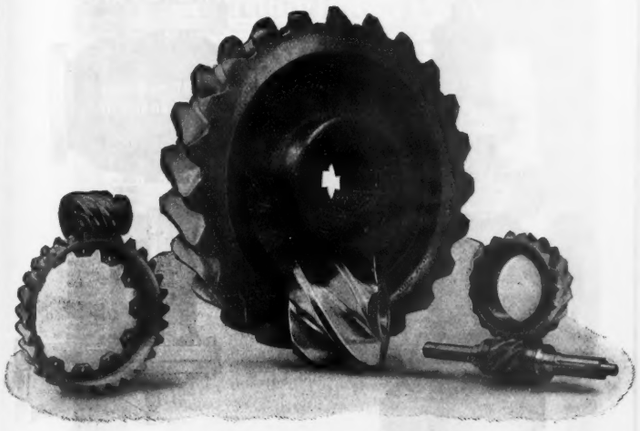

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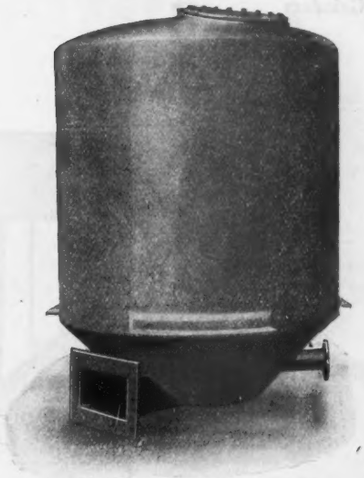

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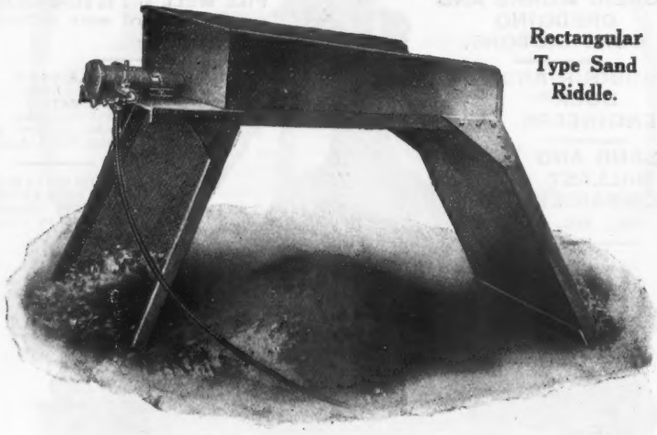

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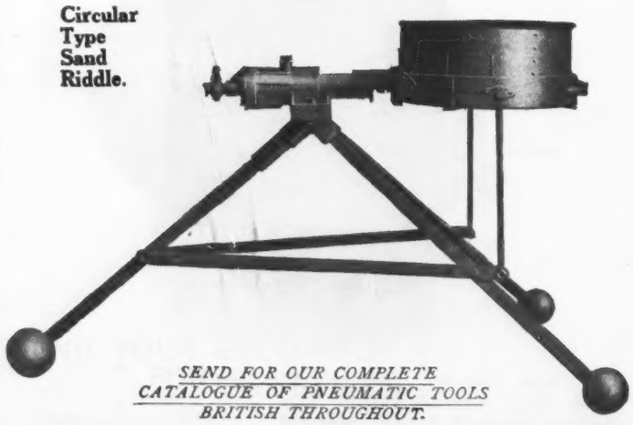

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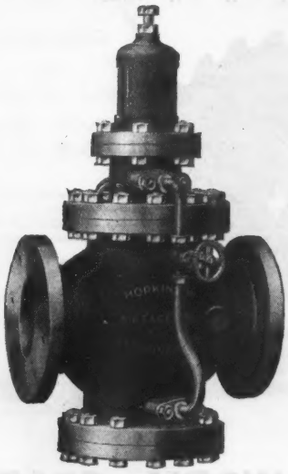
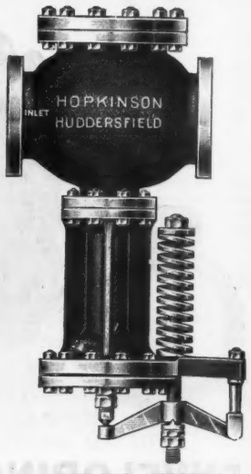


HOPKINSON'S "METACENTRE" REDUCING VALVE. FIG. 9002.



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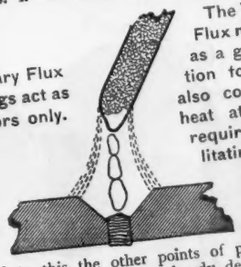

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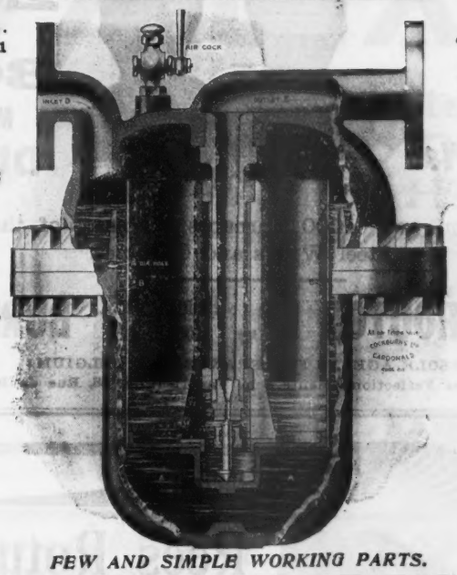

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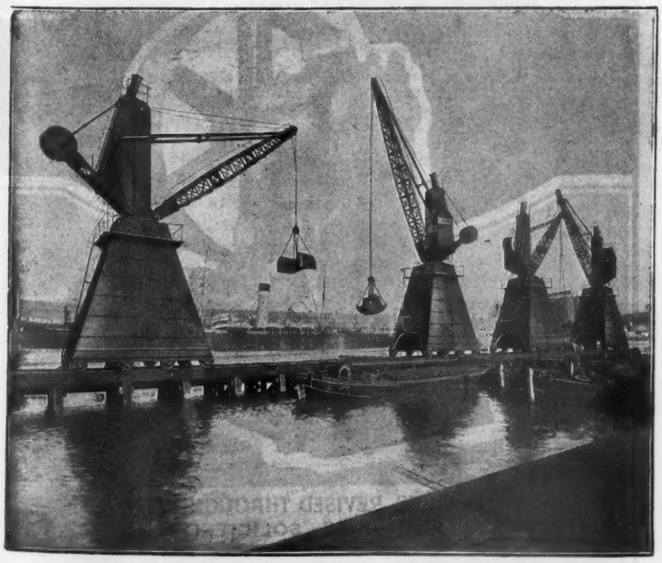

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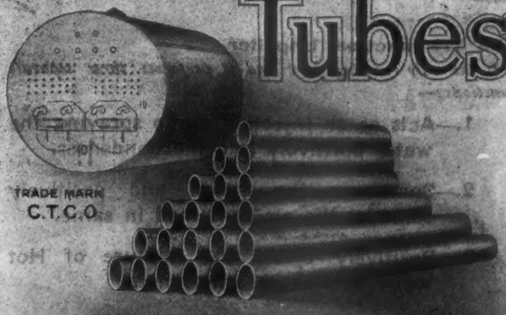

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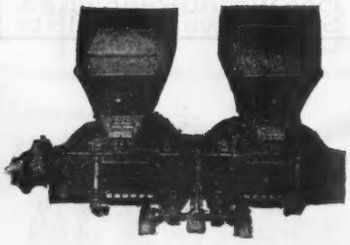

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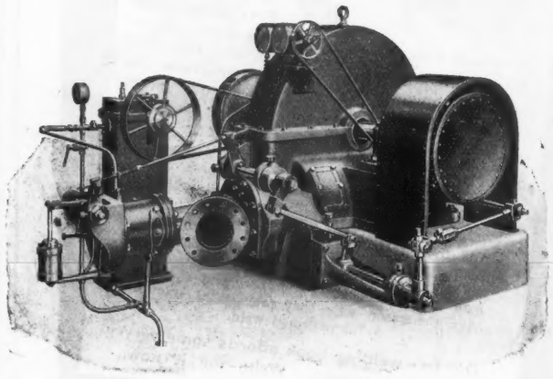

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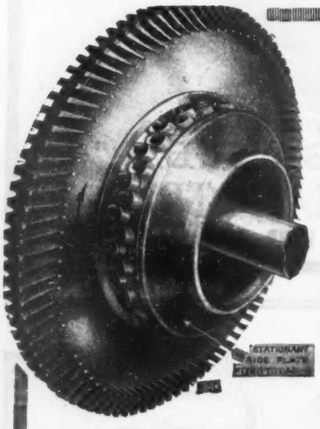

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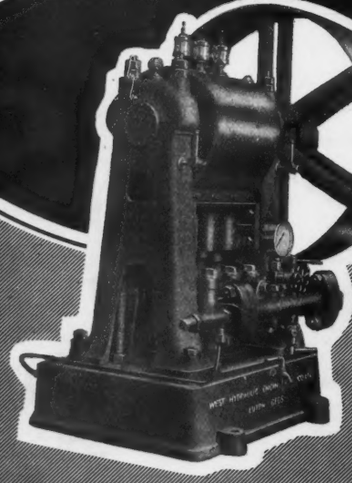

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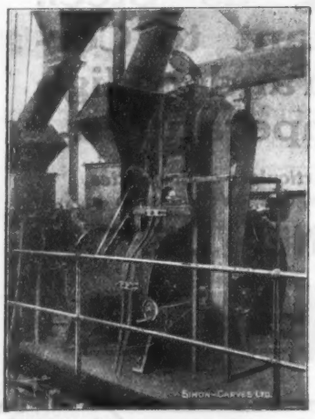

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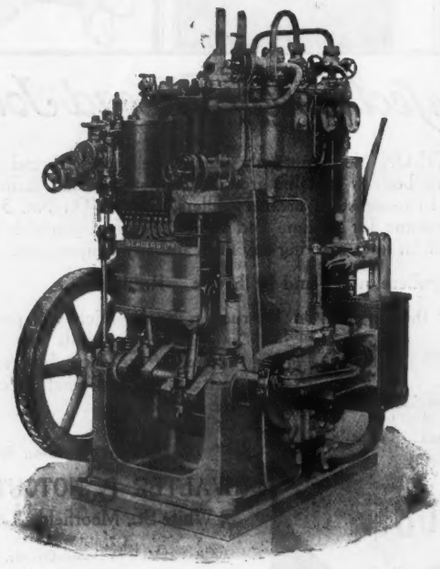

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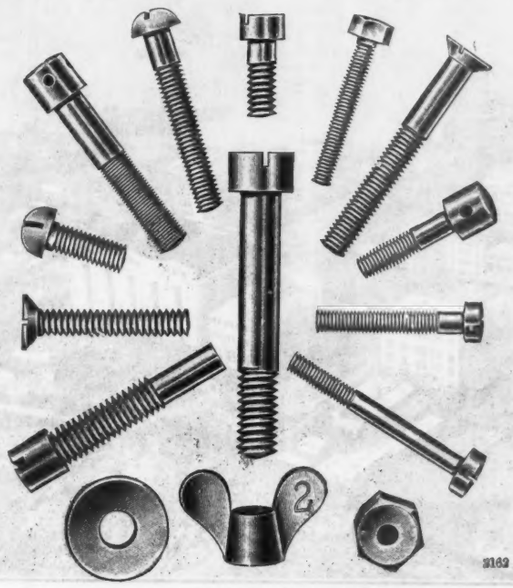

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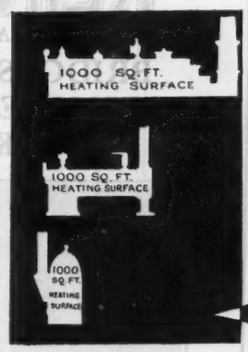

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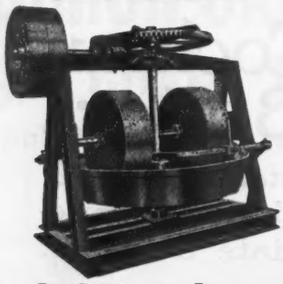

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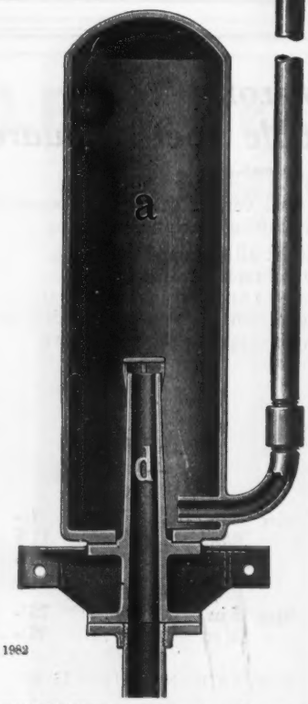

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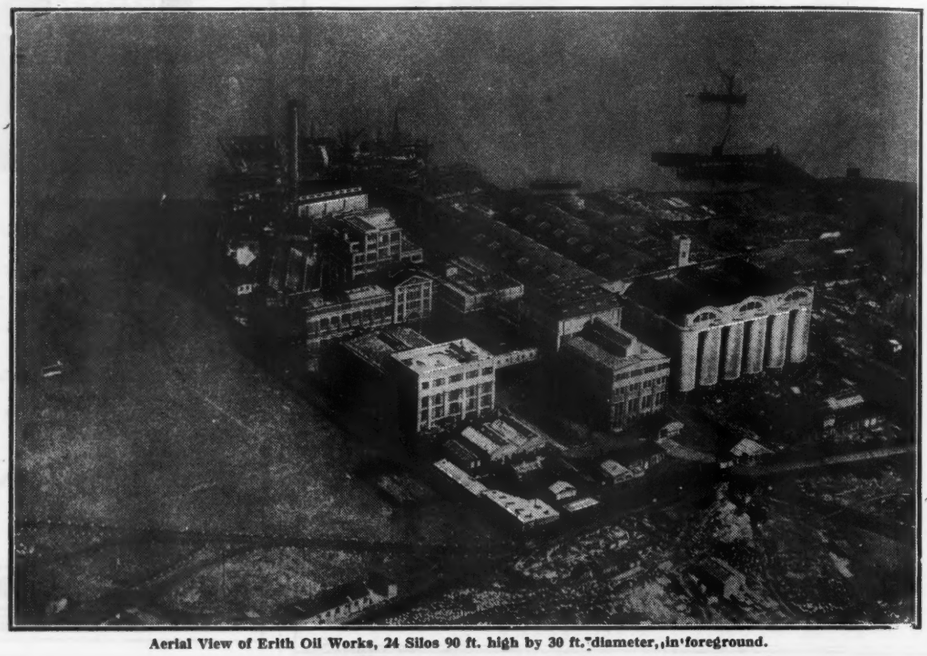

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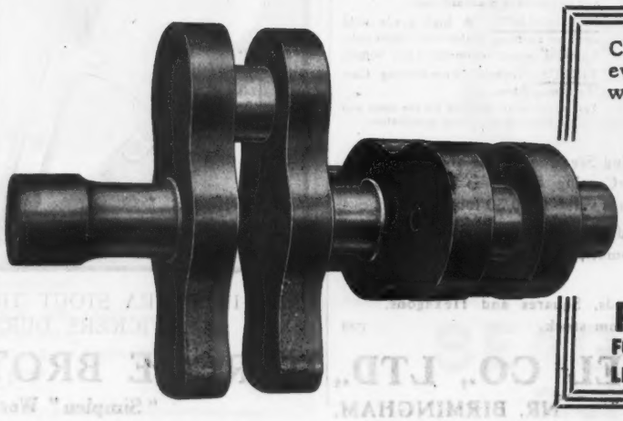

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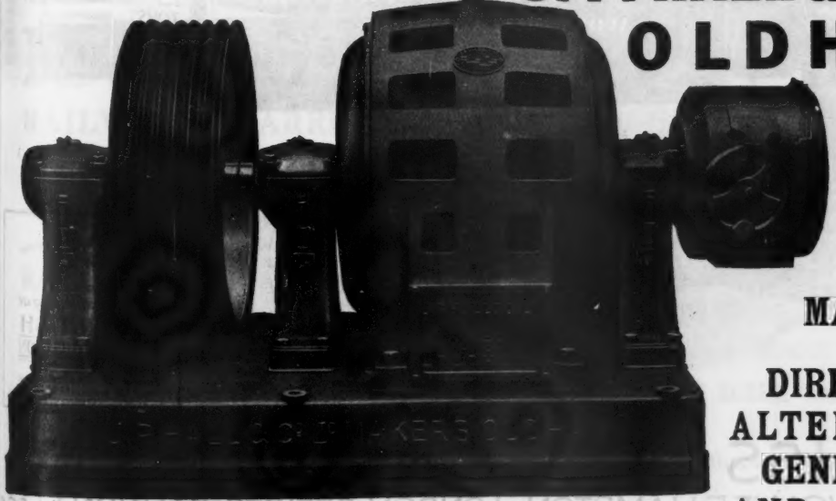

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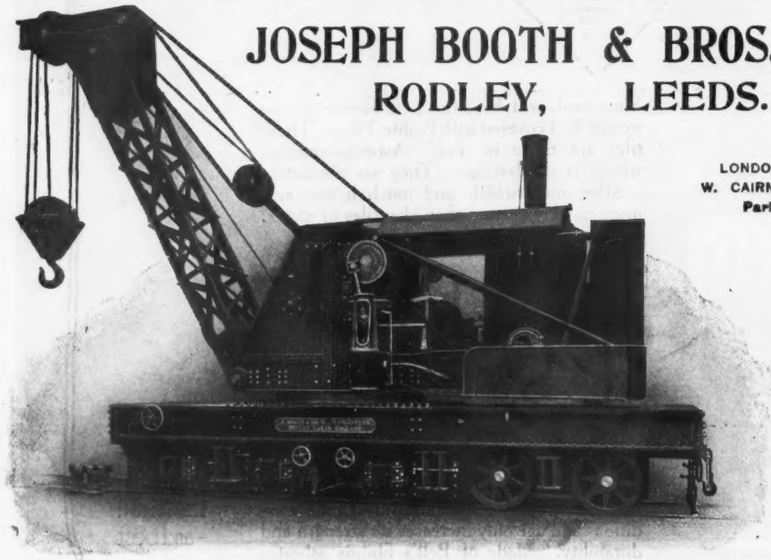

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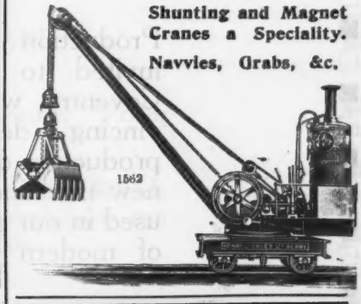
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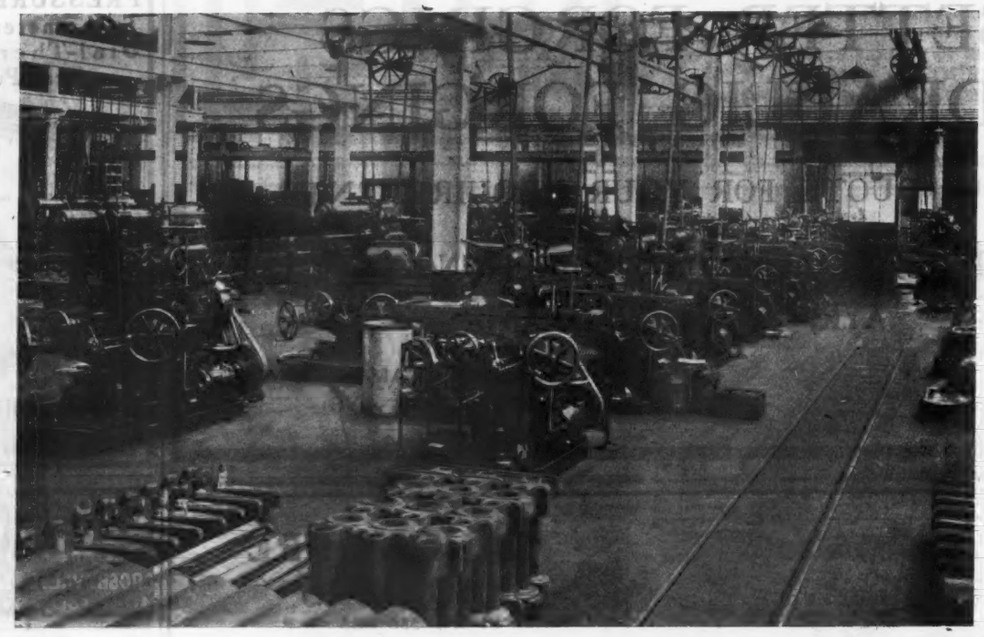

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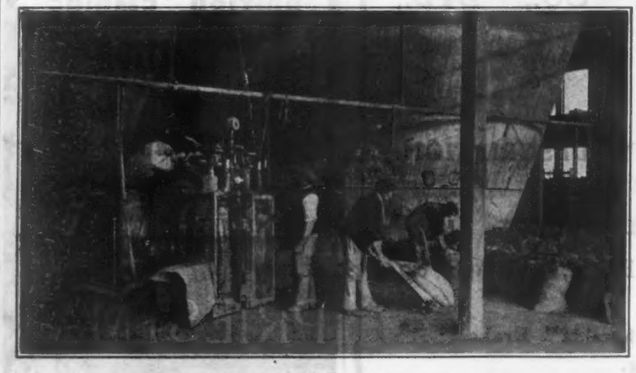

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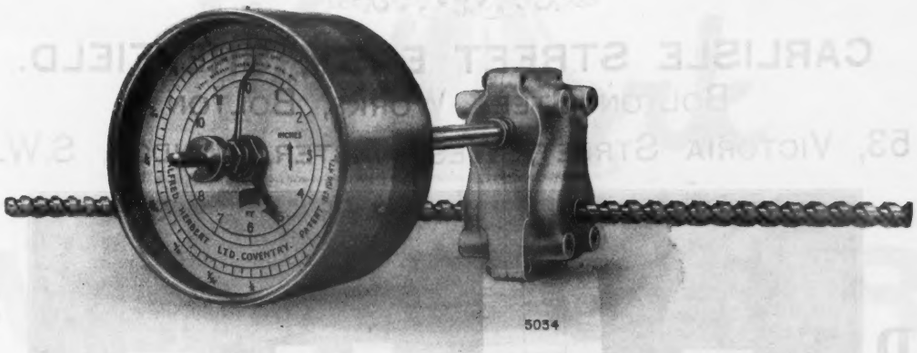

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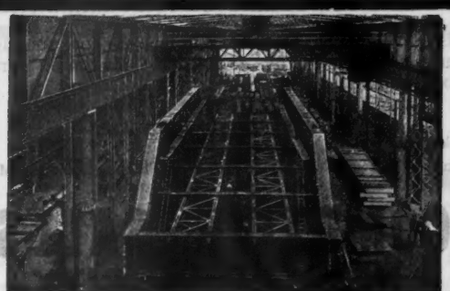

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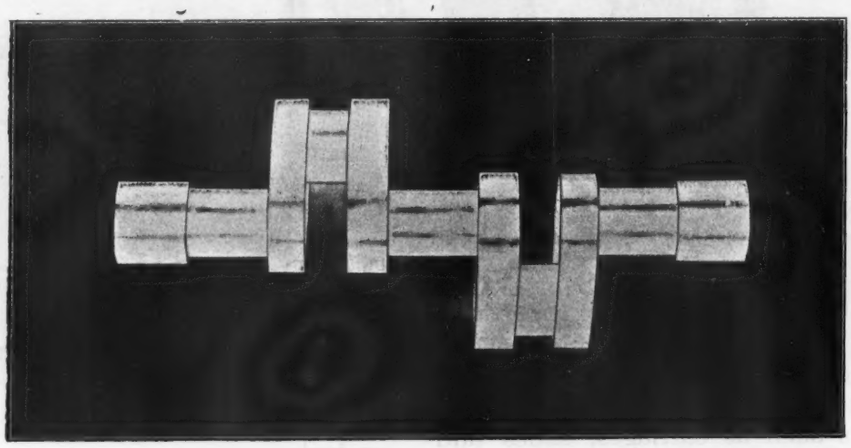

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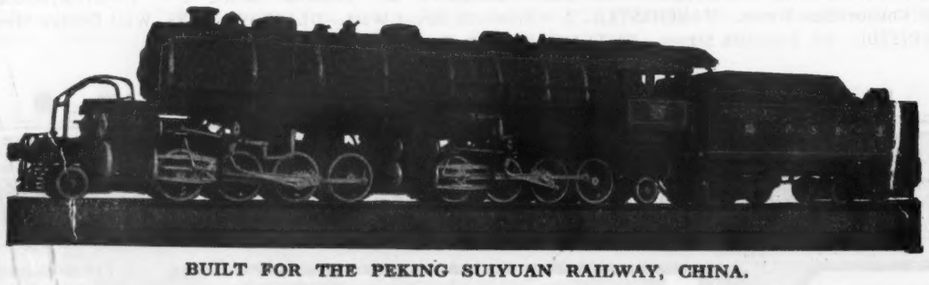

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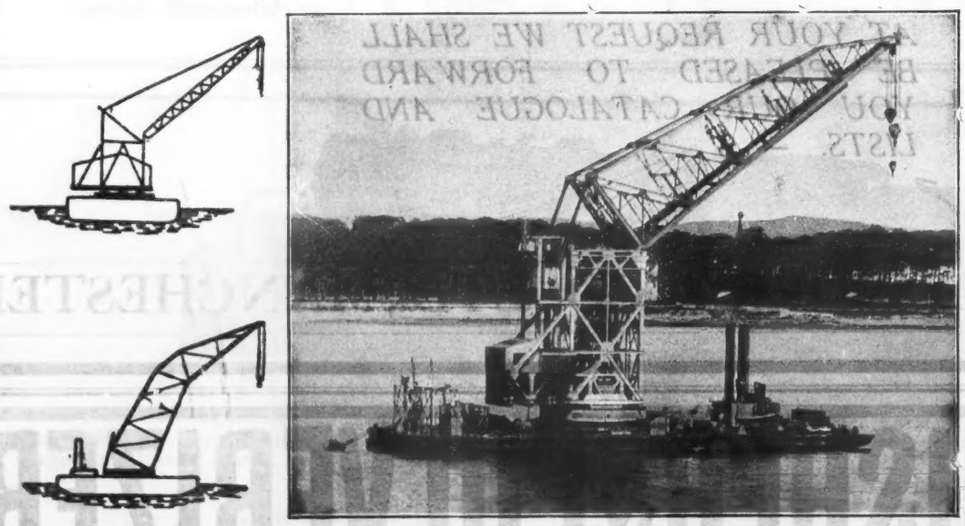

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FIG. 1621.

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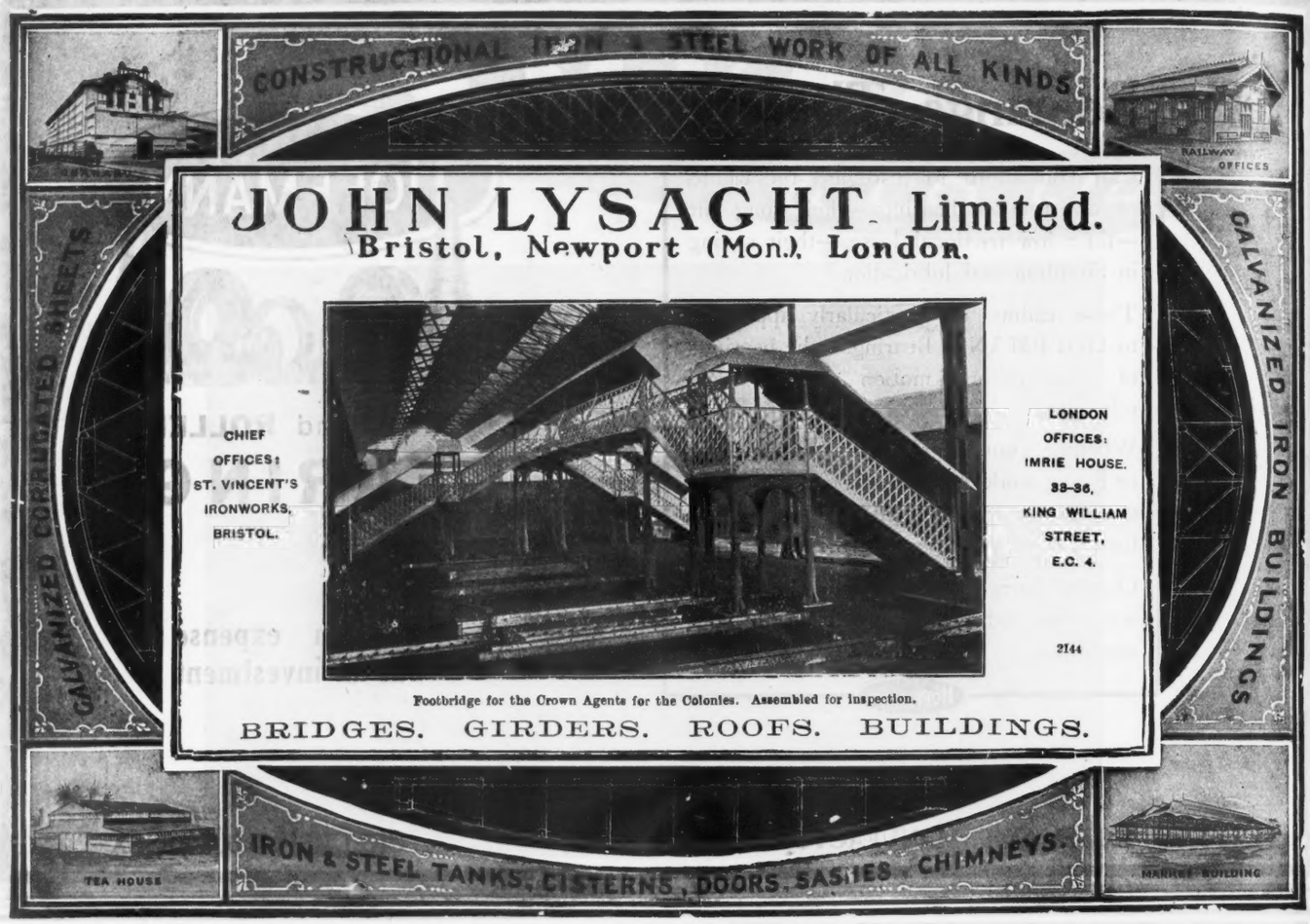
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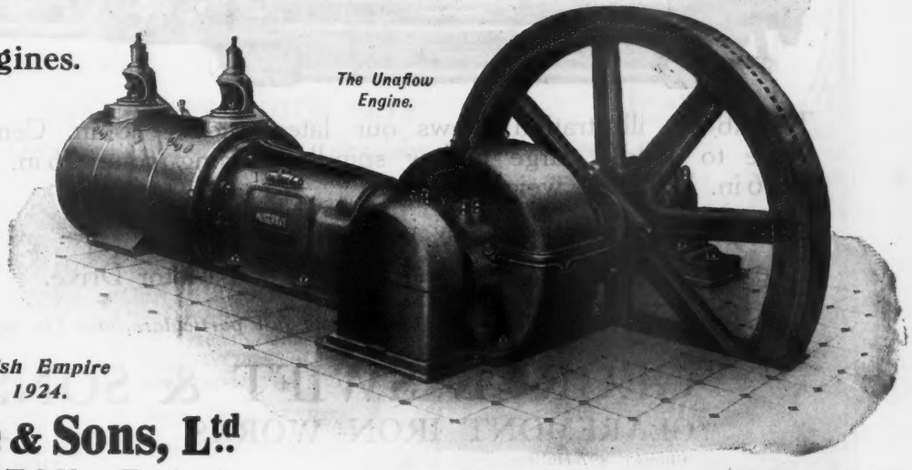

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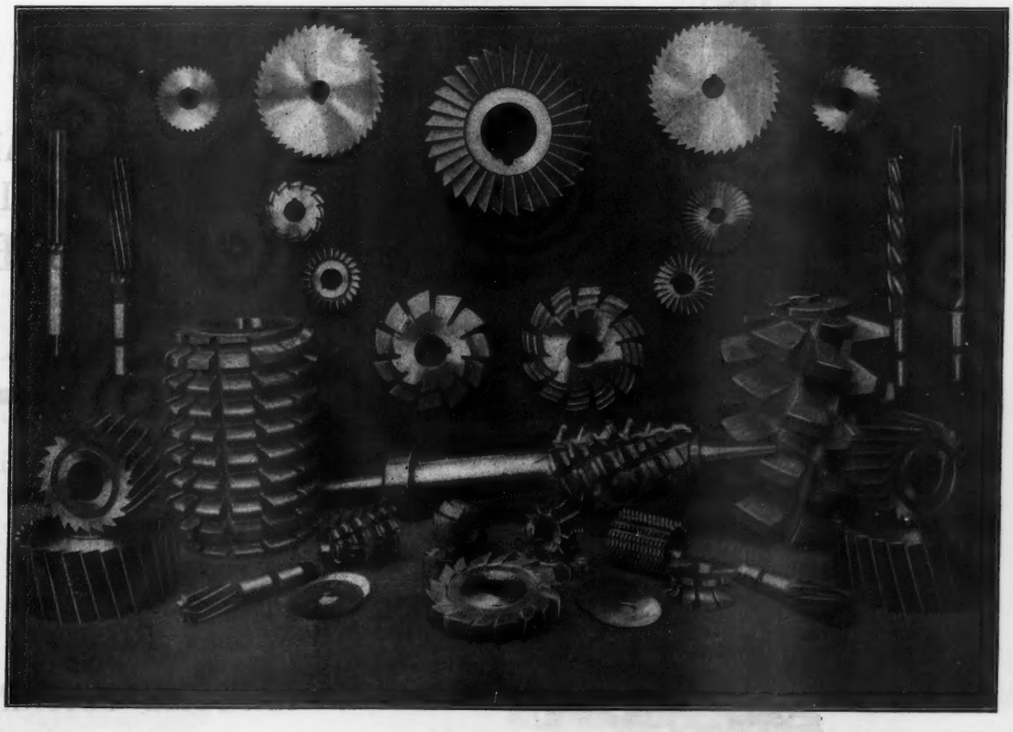

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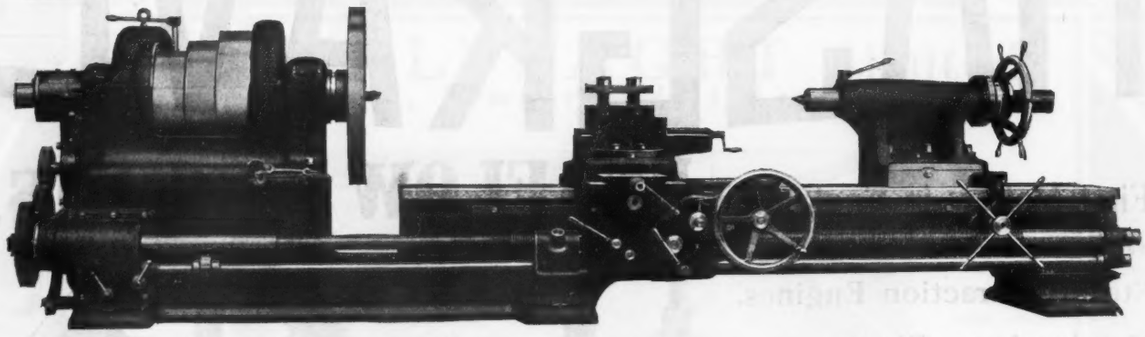

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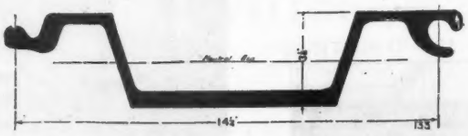

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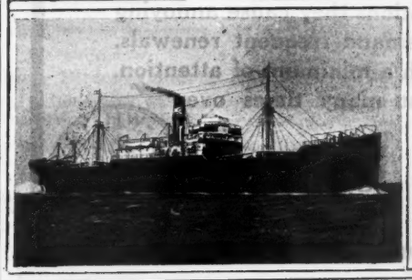

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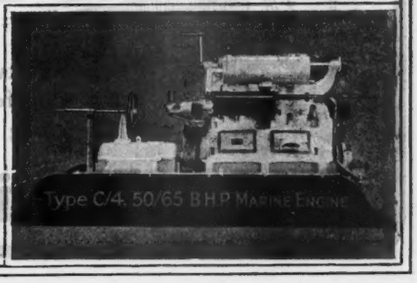

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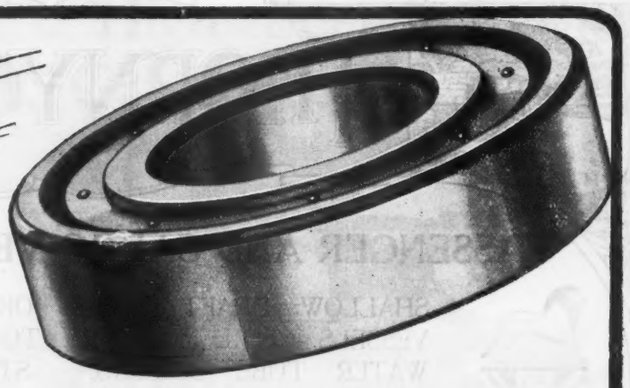

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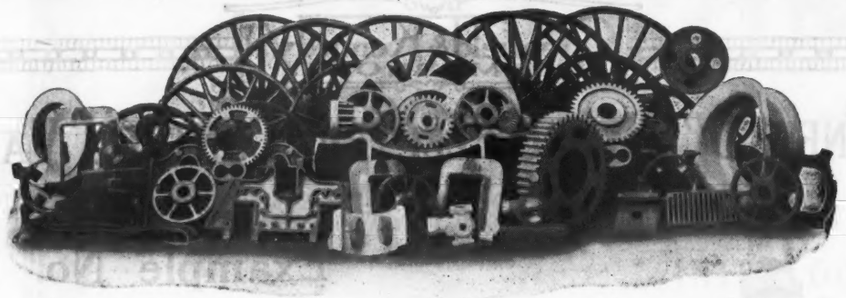

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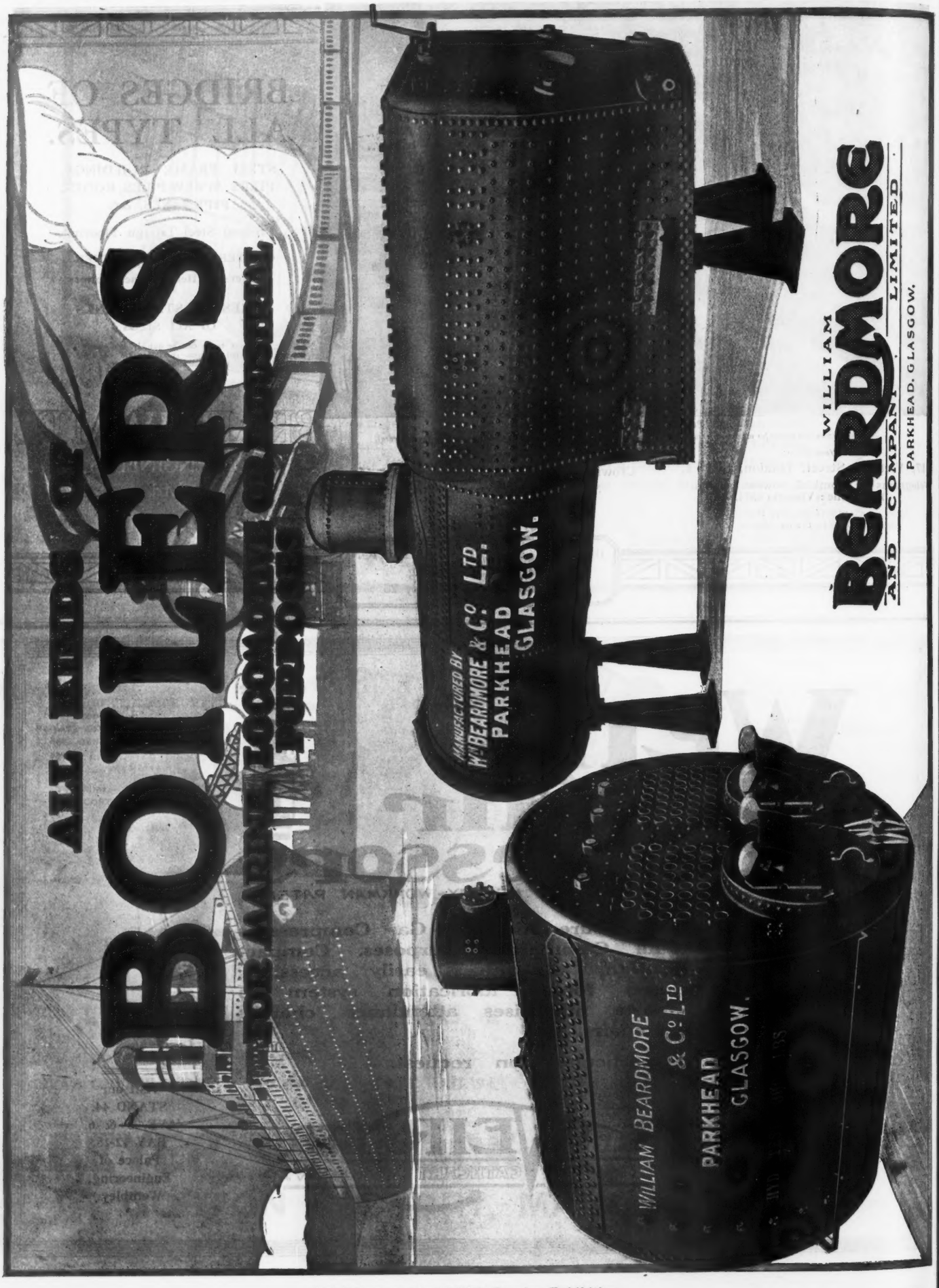

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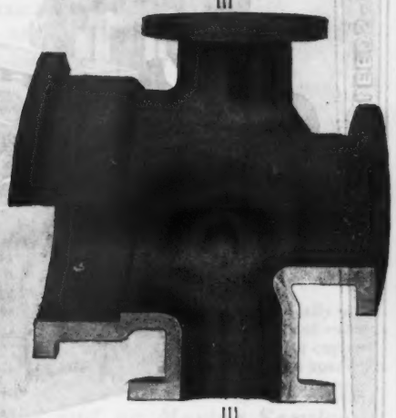

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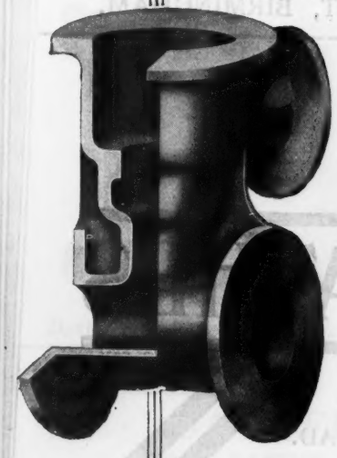

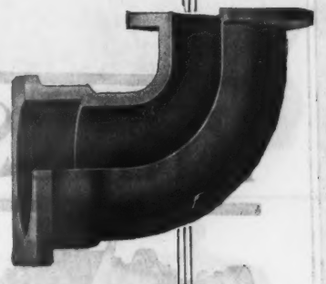

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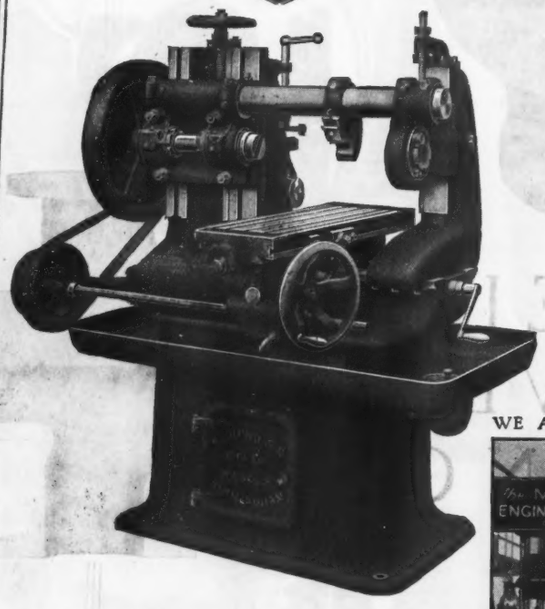

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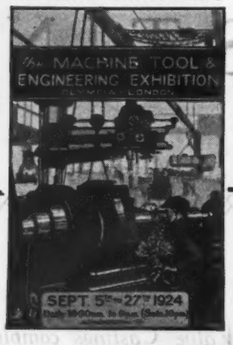

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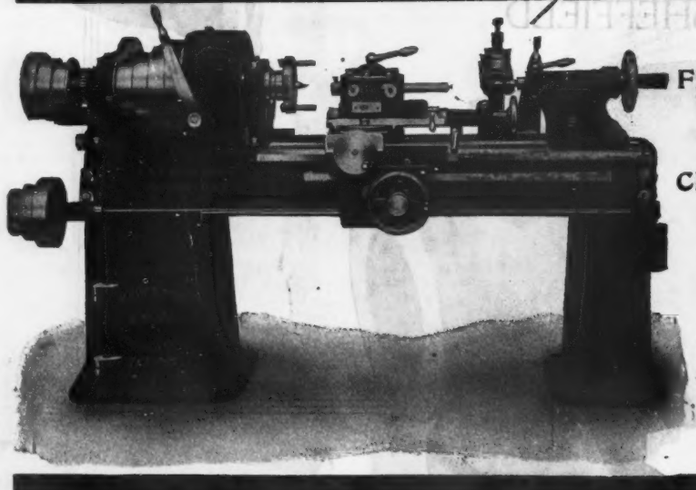

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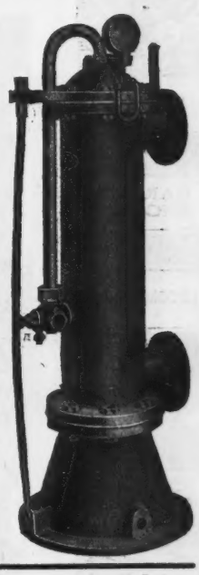

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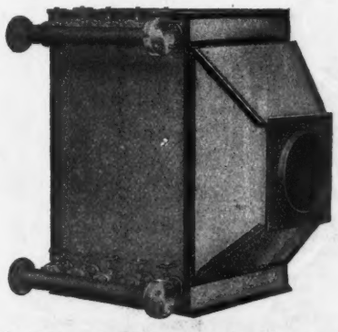

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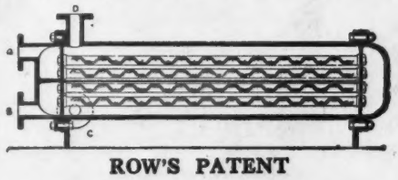

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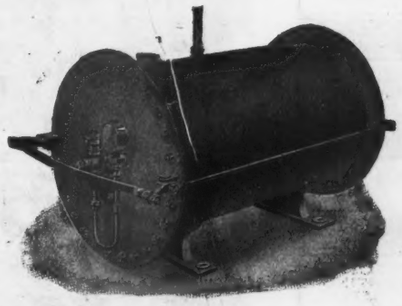

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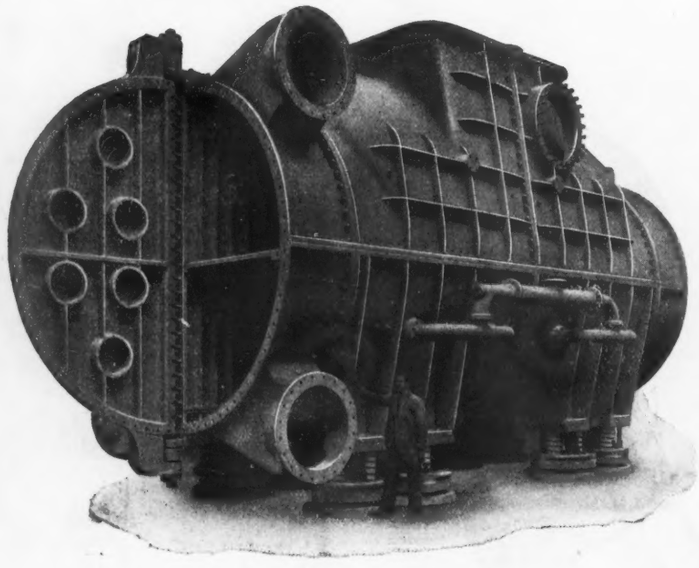
Among the satisfied users of our Condensing Plant are the following Corporations:



In the last five years alone we have supplied Surface Condensing Plant having a total cooling surface of 574,546 square feet. The sizes range from 1350 to 40,000 square feet.

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Giants, if the legends of old are to be credited, were peculiarly delicate creatures, and needed tending with infinite care. This is no less true of "giant" engines. They need continual watching and nursing if they are to be kept immune from breakdown. No one knows this better than the engineer, hence his care in selecting his lubricating oils. Selection, however, is simplified in the case of Shell "All's Well" General Oils, as every oil in every group is selected for its express purpose by qualified chemists.

These oils are sold at competitive prices. SAMPLES and full particulars free on application from your nearest Shell-Mex office, or direct from Shell-Mex, Ltd., General Oils Dept. E.G., Shell Corner, Kingsway, London, W.C.2.

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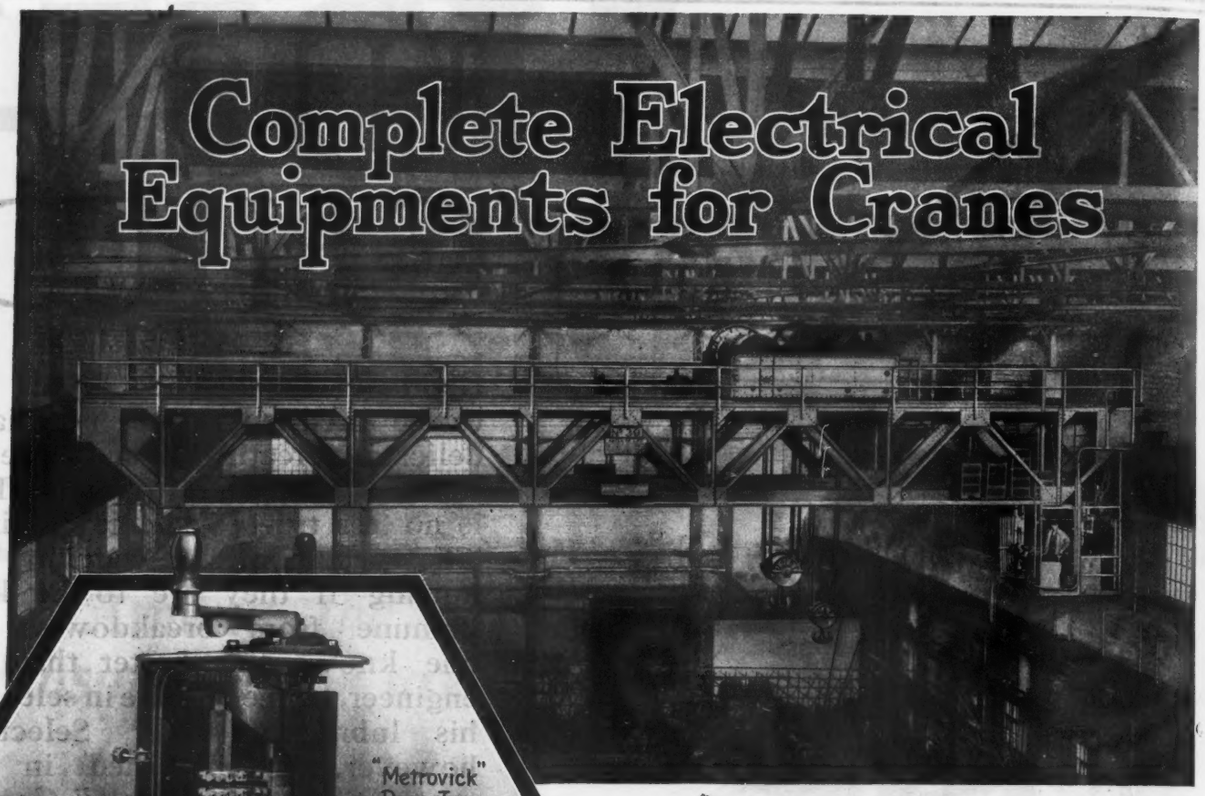
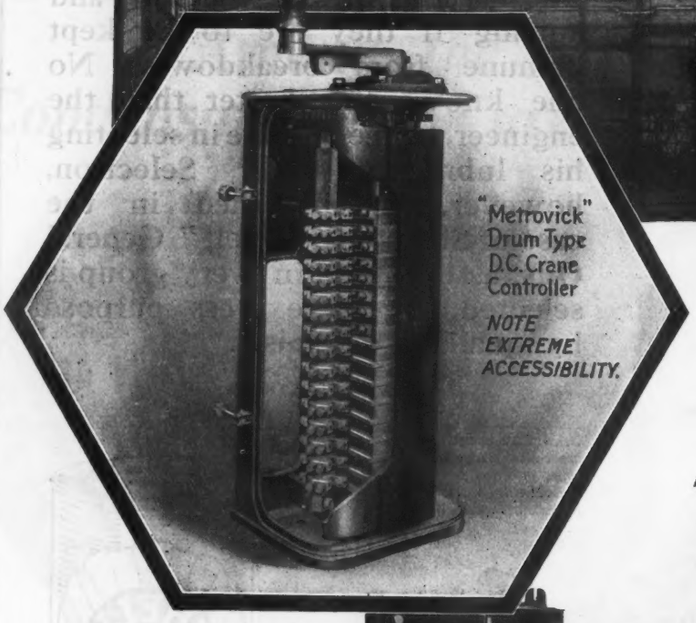
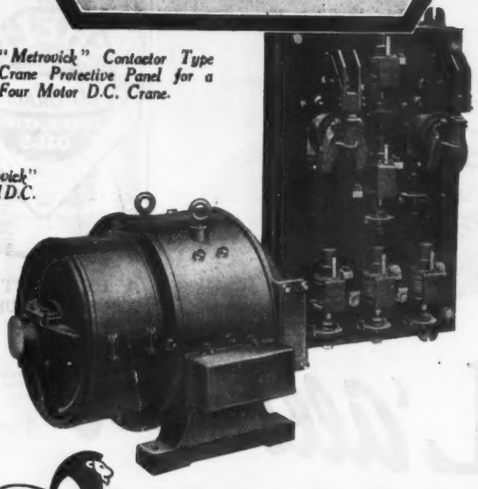
Complete Electrical Equipments for Cranes



100-Ton Overhead Travelling Crane built by Marshall Fleming & Co., Motherwell, and equipped with "Metrovick" Motors, Controllers and Solenoid Brakes.



"Metrovick" Contactor Type Crane Protective Panel for a Four Motor D.C. Crane.



Typical "Metrovick" Totally Enclosed D.C. Crane Motor.

The Metropolitan-Vickers Electrical Co. have made a special study of the design of Electrical Equipments for Cranes, and are prepared to supply the whole of the Electrical gear required for any type of crane.

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MOTORS, CONTROLLERS, BRAKING AND PROTECTIVE APPARATUS

have all been designed with the object of giving perfect and rapid crane control under all conditions.

"Metrovick" Crane Control Gear covers Speed Variation, Reversing, Rheostatic Braking, Diverter Control, Potentiometer Control and Dynamic Braking. Full protection against Overloads and Misuse is afforded by means of the "Metrovick" Crane Protective System.

We have a Department of Engineers specialized in Crane Equipments who are always ready to be consulted and to give advice in connection with any Electrical Crane Installation, complete or in part.

SEND US YOUR SPECIFIC ENQUIRIES or let us send you literature as listed herein.

Drum Controllers	G 1061/1	Crane Protective System	G 63/2—3
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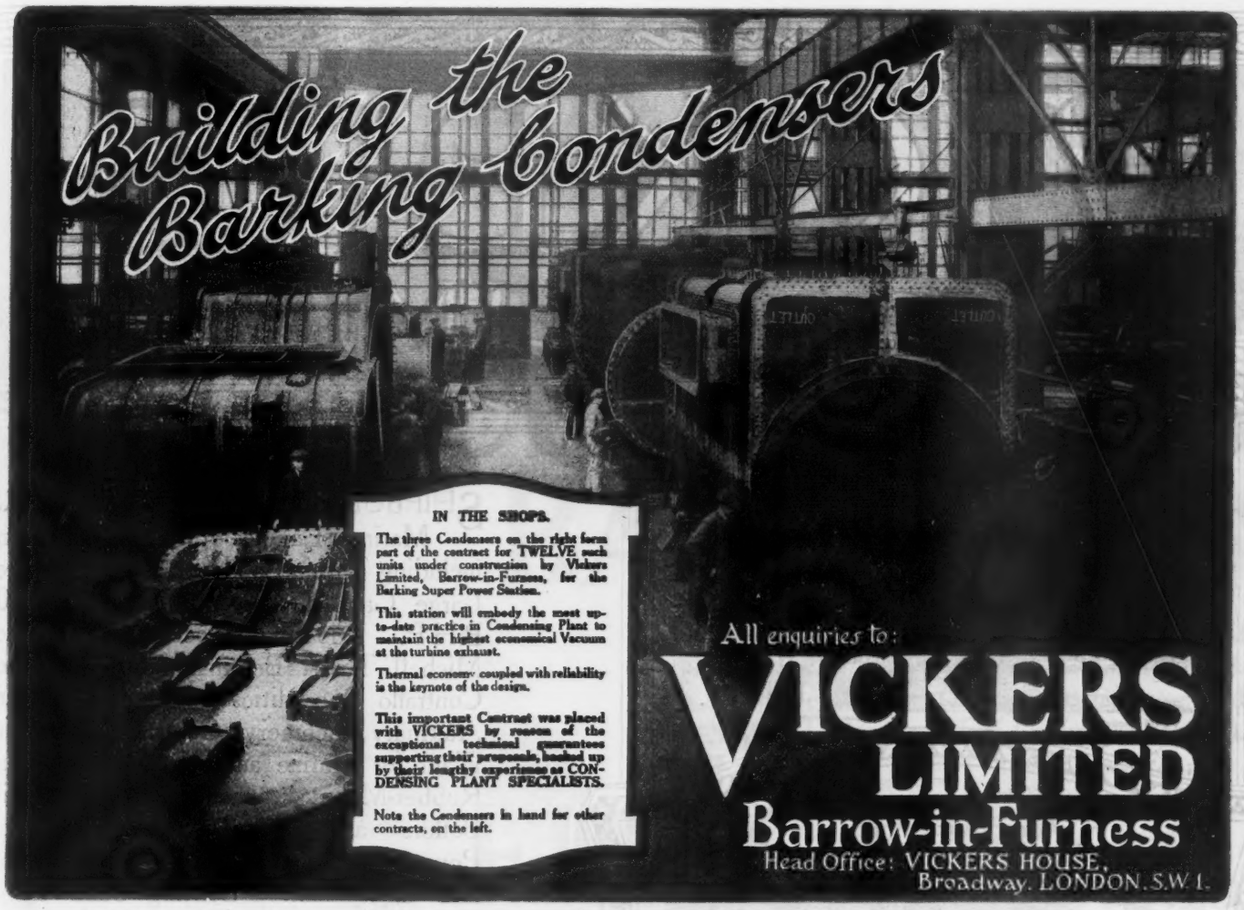
Building the Barking Condensers
IN THE SHOPS.
The three Condensers on the right form part of the contract for TWELVE such units under construction by Vickers Limited, Barrow-in-Furness, for the Barking Super Power Station.
This station will embody the most up-to-date practice in Condensing Plant to maintain the highest economical Vacuum at the turbine exhaust.
Thermal economy coupled with reliability is the keynote of the design.
This important Contract was placed with VICKERS by reason of the exceptional technical guarantees supporting their proposals, backed up by their lengthy experience as CONDENSING PLANT SPECIALISTS.
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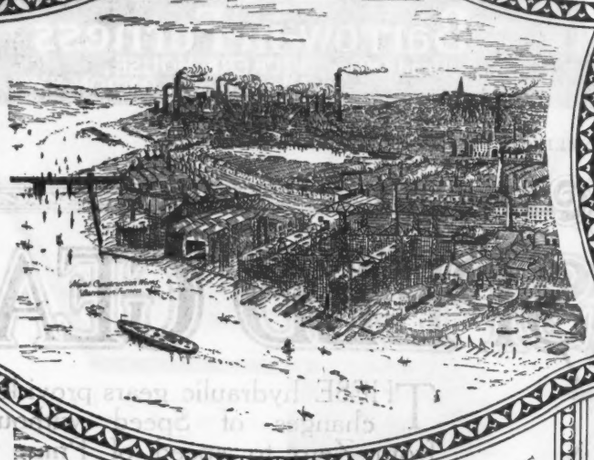

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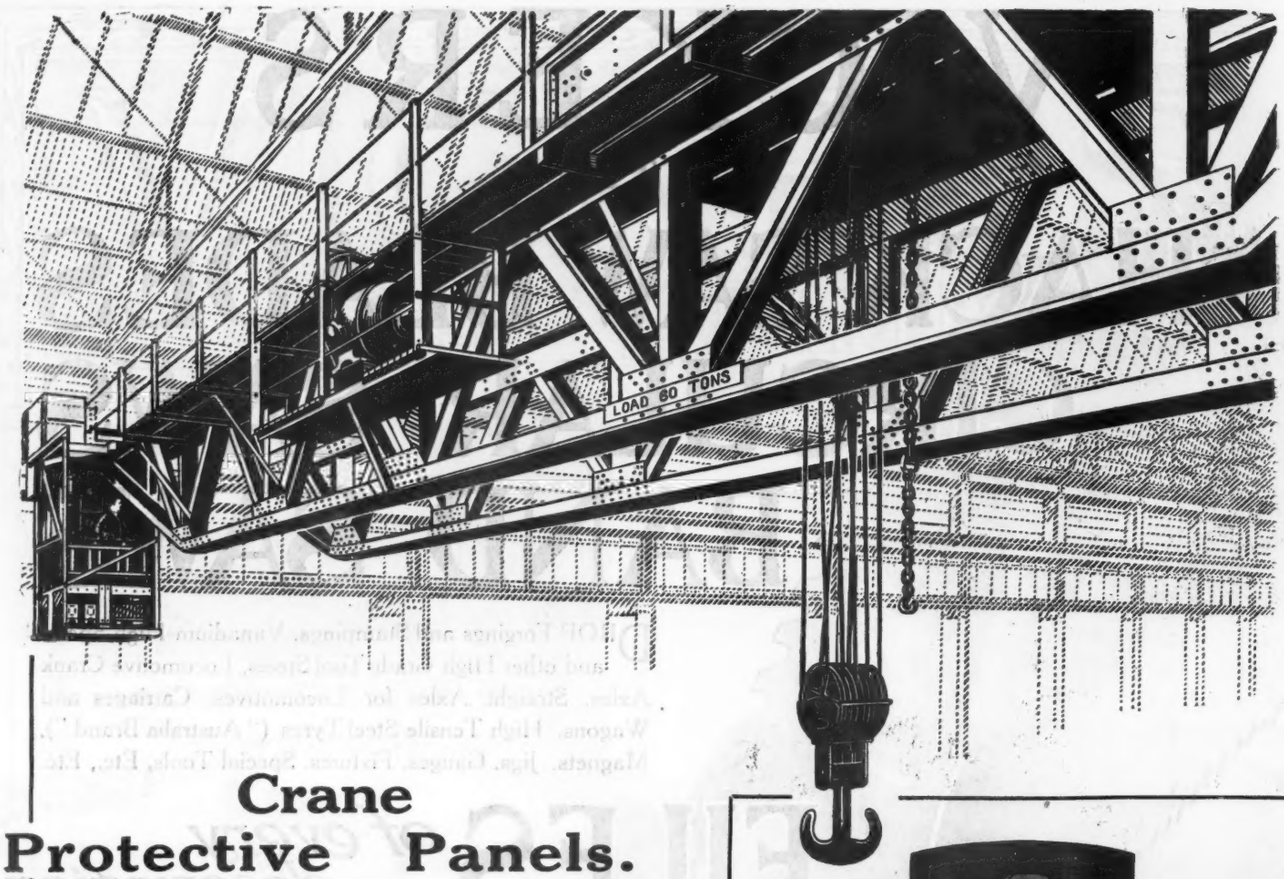

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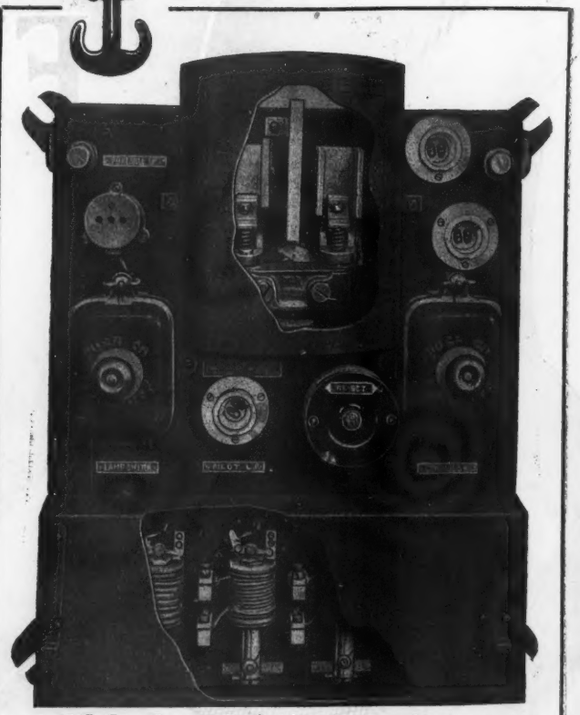
The ordinary fuse and circuit breaker method of protection has become obsolete for crane service due to the restrictions imposed on the output and the time lost for re-setting after operation.

B.T.H. Crane Protective Panels are fitted with contactor type circuit breakers which may be readily re-set by means of a conveniently placed push-button, and overload time-lag relays are incorporated to allow the crane to be operated at its highest limit of output. Low voltage protection is an inherent feature of contactor type circuit breakers, and, if desired, the contactors can be readily interlocked with the controllers as a further safeguard.

For further particulars please write for P.L. 5340.



D.C. Crane Protective Panel with auxiliary control equipment (covers broken to show contactors and relays).

When visiting the British Empire Exhibition do not fail to inspect the B.T.H. Stand, adjacent to the Lounge, in the Palace of Engineering.

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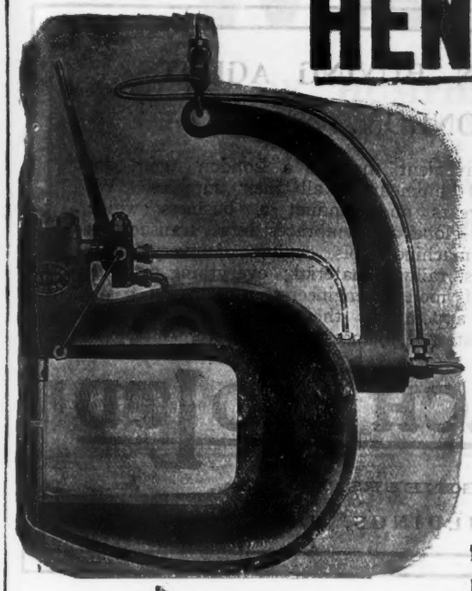

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For a Working Pressure of 1500 lbs. per sq. inch.

Portable Bear Type.	15 in. Gap.	33 in.	Daylight.	Power 22 tons.	Bow Hanger.
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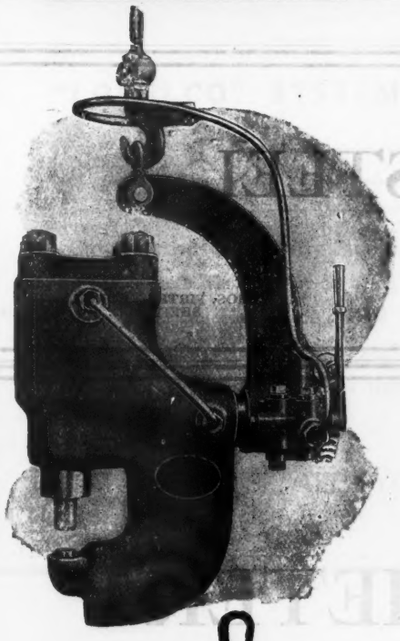
Portable Hinge Type.	18 in. Gap.	15 in.	Daylight.	Power 25 tons.	Bow or Eye Bolt.
Portable Hinge Type.	24 in. Gap.	15½ in.	Daylight.	Power 20 tons.	Universal Hanger.
Portable Hinge Type.	15 in. Gap.	15 in.	Daylight.	Power 20 tons.	Bow Hanger.
Portable Hinge Type.	15 in. Gap.	10 in.	Daylight.	Power 15 tons.	Bow Hanger.
Portable Hinge Type.	24 in. Gap.	16 in.	Daylight.	Power 25 tons.	Bow Hanger.
Portable Fire Hole Door.	5 in. Gap.	12 in.	Daylight.	Power 30 tons.	Bow Hanger.



For a Working Pressure of 1000 lbs. per sq. inch.

Portable Flue Type.	9 in. Gap.	4 in.	Daylight.	Power 30 tons.	Bow Hanger.

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Portable Hinge Type.	20 in. Gap.	20 in.	Daylight.	Power 30 tons.	Bow Hanger.

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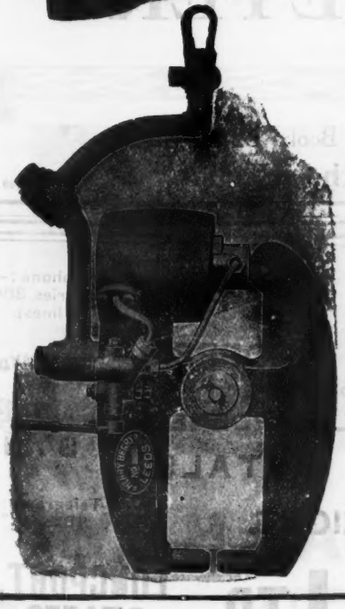

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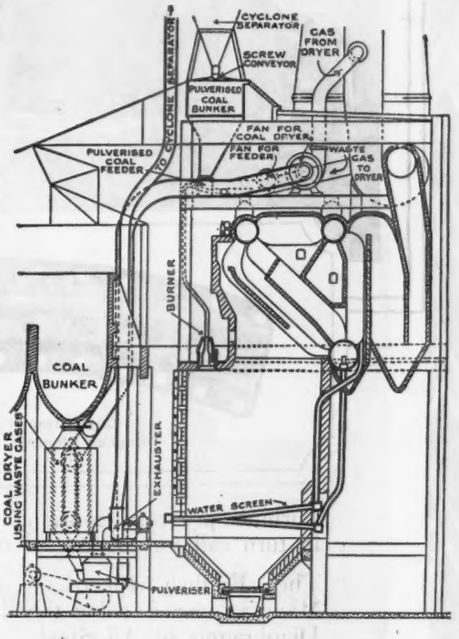
"LOPULCO" SYSTEM OF PULVERISED FUEL.

Patent Rights held by Underfeed Stoker Co. for various countries.

Cross Section of the Vitry Station of the Scé. Anme. Union d'Electricité, Paris, where the system is being installed. There are four boilers, each with a heating surface of 16,678 square feet. Normal Evaporation per boiler per hour from and at 212°F., 140,580 lbs. Maximum Evaporation per boiler per hour from and at 212°F., 210,870 lbs.



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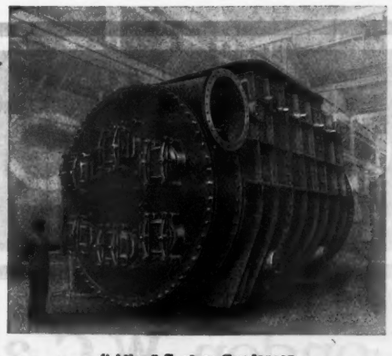

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CONDENSING PLANT

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HIGHEST VACUUM — MAXIMUM ECONOMY

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RELIABLE SERVICE.

Built in all sizes up to 25,000 Kw. capacity.

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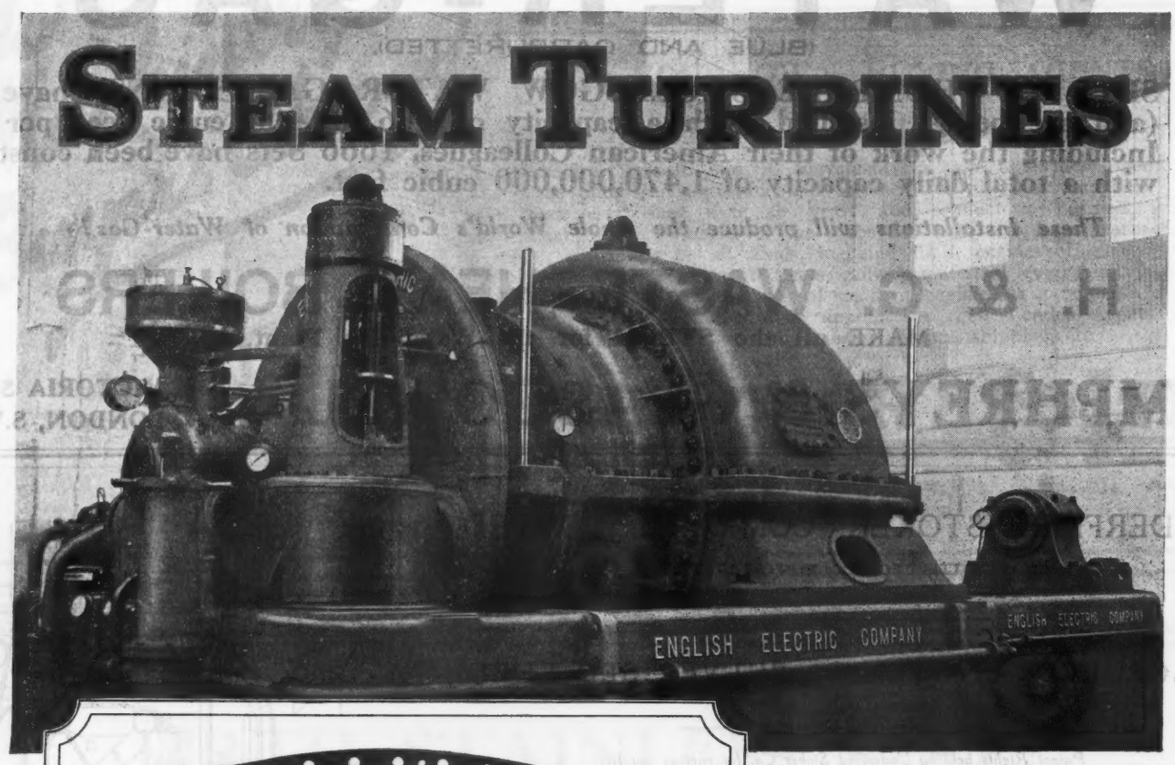

20,000 K.W. Steam Turbine—High Pressure Portion in Steel

Cast Steel Nozzle Plate for
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ALL STEEL NOZZLE PLATES AND DIAPHRAGMS

Turbine progress continually demands higher Pressures and high Temperatures, these in turn call for the use of new materials.

The English Electric Company have used their association with eminent Steel Manufacturers to solve the difficulties in making such parts as Nozzle Plates and Turbine Diaphragms of All Steel.

The illustrations show a 20,000 K.W. 1,500 R.P.M. Steam Turbine in course of erection, and an All Steel Nozzle Plate with which this machine is fitted.

A more detailed description will be forwarded upon receipt of application.

TURBINE ADVT. SERIES, No. 3. 9514

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FORGING MANIPULATORS

used in conjunction with Forging Presses

(1) Eliminate labour required for manipulating the forgings.

(2) Save much time in handling, thus greatly increasing output.

(3) Save fuel, as the more rapid rate of forging reduces the number of heats necessary.

These "mechanical workmen" never tire and are not troubled by intense heat. All motions required for rapid forging are instantly available and under the control of a single operator mounted on the machine.

They are specially suitable for installation with "Davy" Forging Presses as they enable the most to be made of the high speed of working of the "Davy" Press.

Example of Production :

A 1000 ton Press with Manipulator has regularly cogged down **100 tons of 3 ton ingots per 8 hour shift,** the ingots being reduced from 18" square to 9" × 10" and cut up under the press.

6 ton Manipulator, Universal Ground Type.

By arrangement with the European Manufacturers for the Alliance Machine Co., Messrs. Stothert and Pitt, Ltd., we are acting as selling agents for "Alliance" Manipulators for forging installations.

"DAVY" HIGH-SPEED FORGING PRESSES, 100 to 12,000 tons power.
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LANCASHIRE, CORNISH AND "BLAKE" WASTE HEAT BOILERS.

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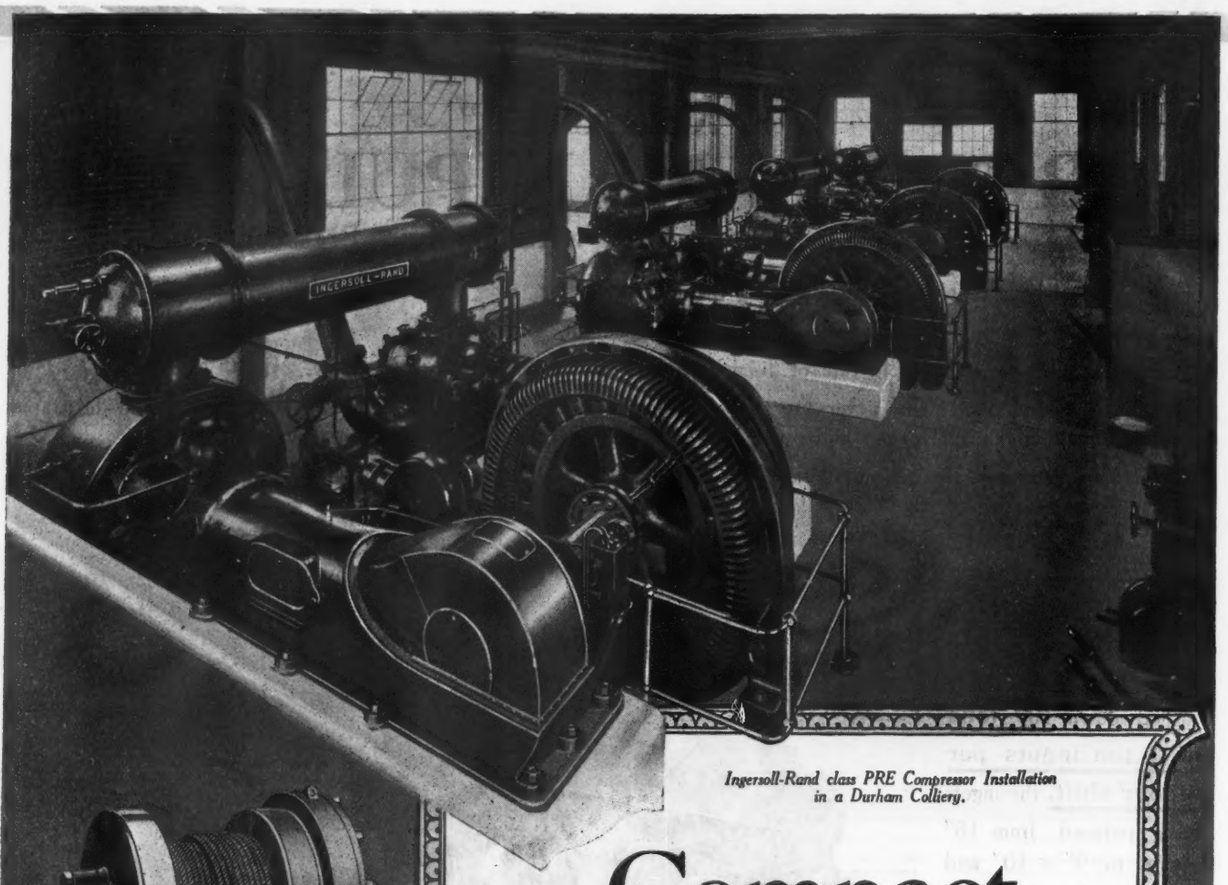
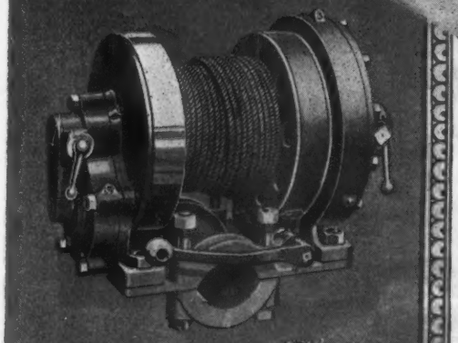
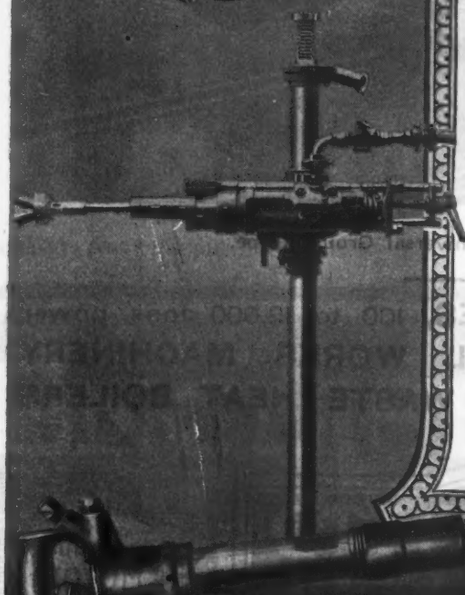


Ingersoll-Rand class PRE Compressor Installation in a Durham Colliery.





Compact

FLOOR space is valuable, and the compressor that is compact in design may easily save you building charges. INGERSOLL-RAND Class PRE Compressors follow our standard duplex construction and have the motor mounted on compressor shaft between the cylinders, only two bearings in line. The result is small floor space occupied.

Other interesting features of the Class PRE Compressors are:—

The Ingersoll-Rand Plate Valve, which needs no lubrication.

The 5-step "Clearance Controller," which ensures high efficiency on full and partial loads.

The Improved Intercooler which reduces the driving HP. required, removes moisture and ensures low discharge temperature.

We invite enquiries for all types of Compressors, stationary or portable, for steam, petrol, belt or electric drive, for Pneumatic Tools and Cameron Pumps.

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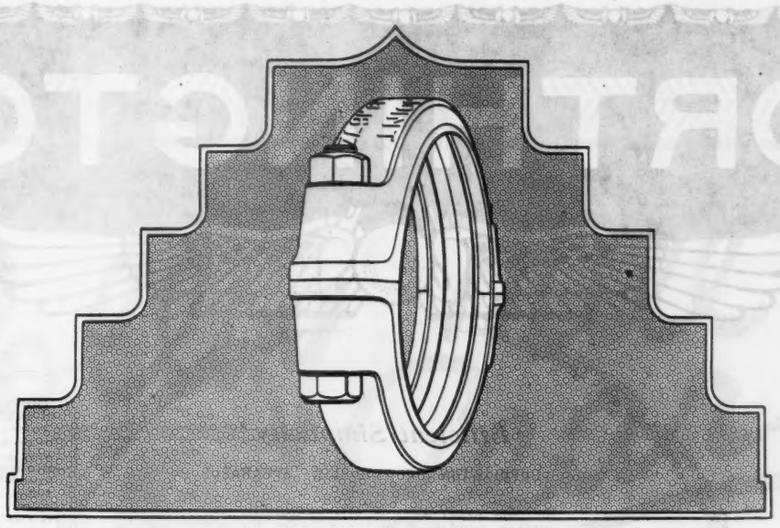
MANCHESTER - - - - 196, Deansgate.

Ingersoll-Rand

1934



Better, even, than no joints at all.

ASKED what he thought might be the very best way of joining pipes, many a man would answer that—if it were all the same to you—he would prefer to have no joints at all.

BUT, even if that were possible, he would nevertheless be wrong, for his one-piece piping would be a rigid thing, lying stiffly on ground that is never still. Fixed and unalterable, permitting no changes and no extensions, its only virtue would be that, until overtaken by some untoward fate, it would not leak.

AND leaks—as you know—are the very dickens.

BEHIND all thoughts on pipe-joints is that dread of leaks, for a leaking pipe is like a purse with a hole in it, failing in the very purpose for which it exists.

PLAINLY, then, the proper way to join tubes is by joints which will always remain leaktight in spite of rough use and movement of the ground.

SUCH are Victaulic joints, having enough flexibility to allow movement of the pipes without leakage, permitting freely their expansion and contraction, and unharmed by vibration—better even than 'no joints at all.'

WHEN ordering S.T.C. tubes for use in the colliery, specify these Victaulic joints, the cost, above a certain size, is no higher.

The Scottish Tube Company Ltd.

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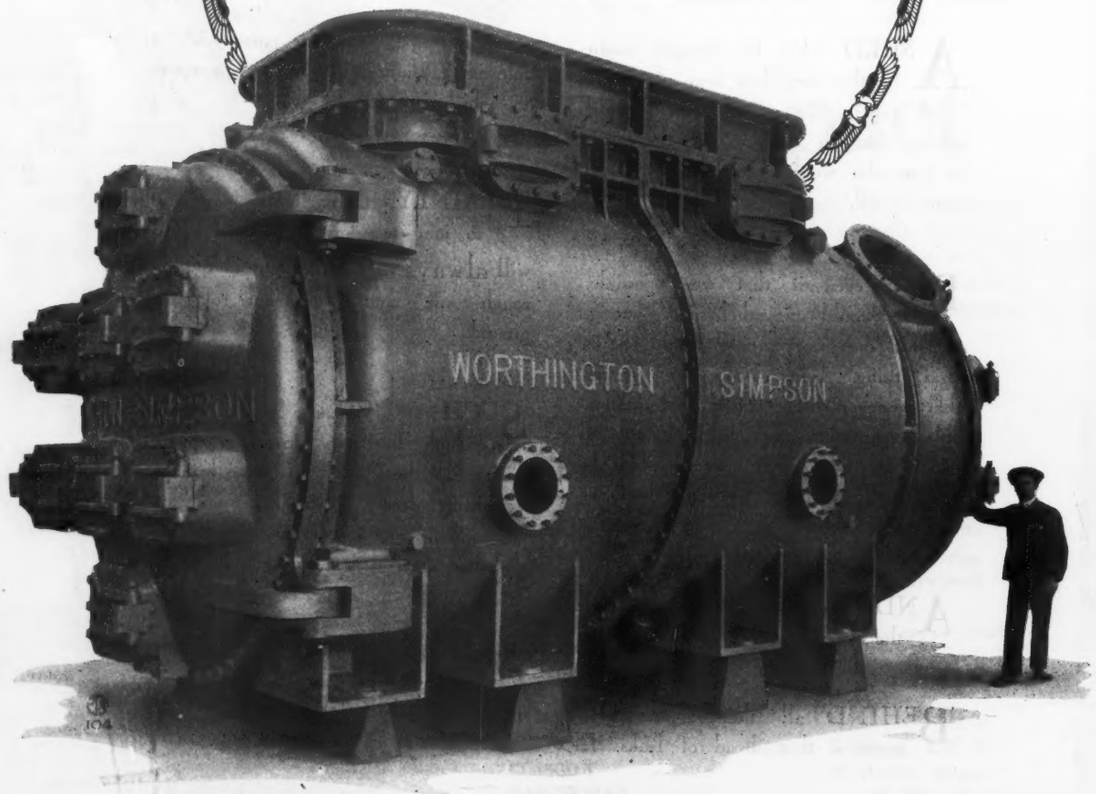

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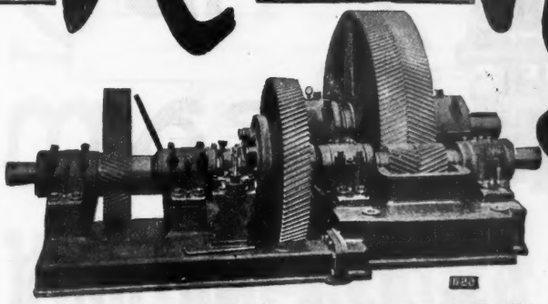
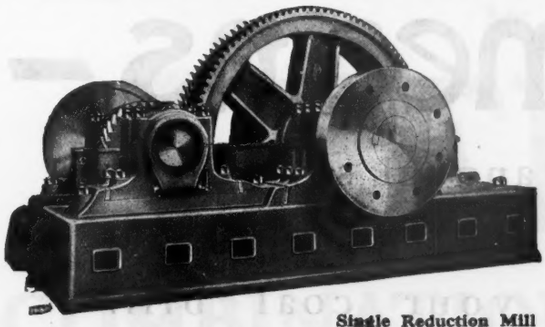
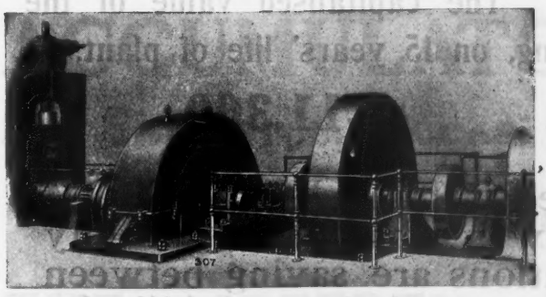


Patent combined starting roll turning and rolling mill drive for Tin Plate Mills as supplied to five South Wales Mills.



Single Reduction Mill Gears up to 20,000 HP.



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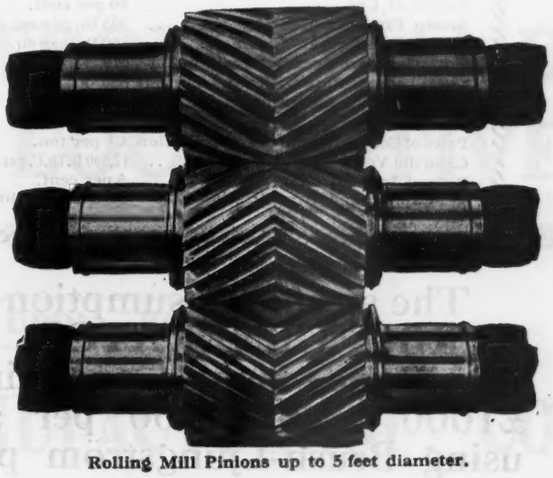

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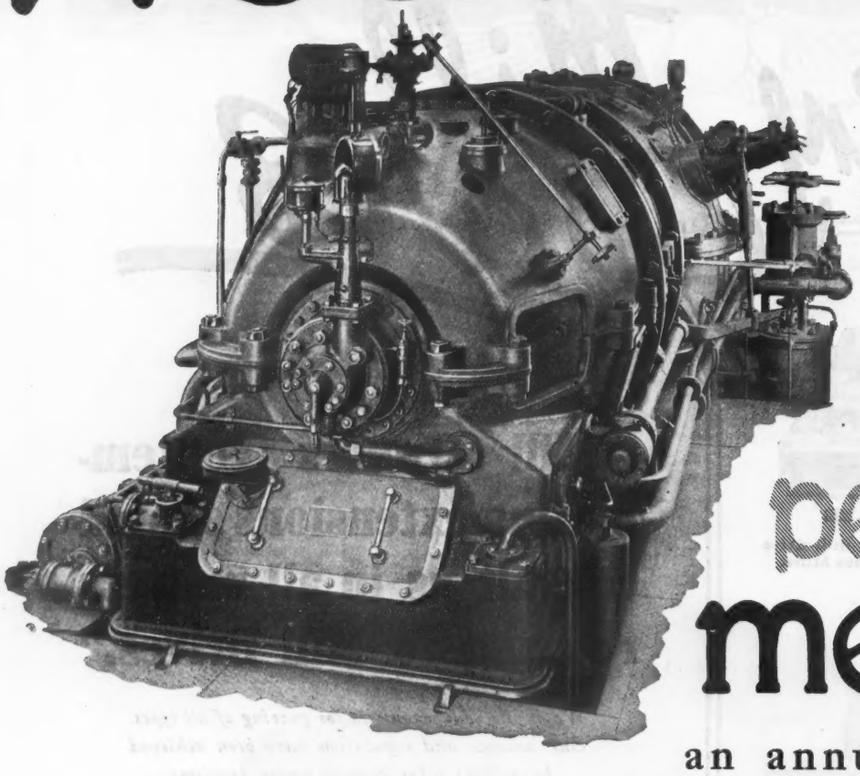

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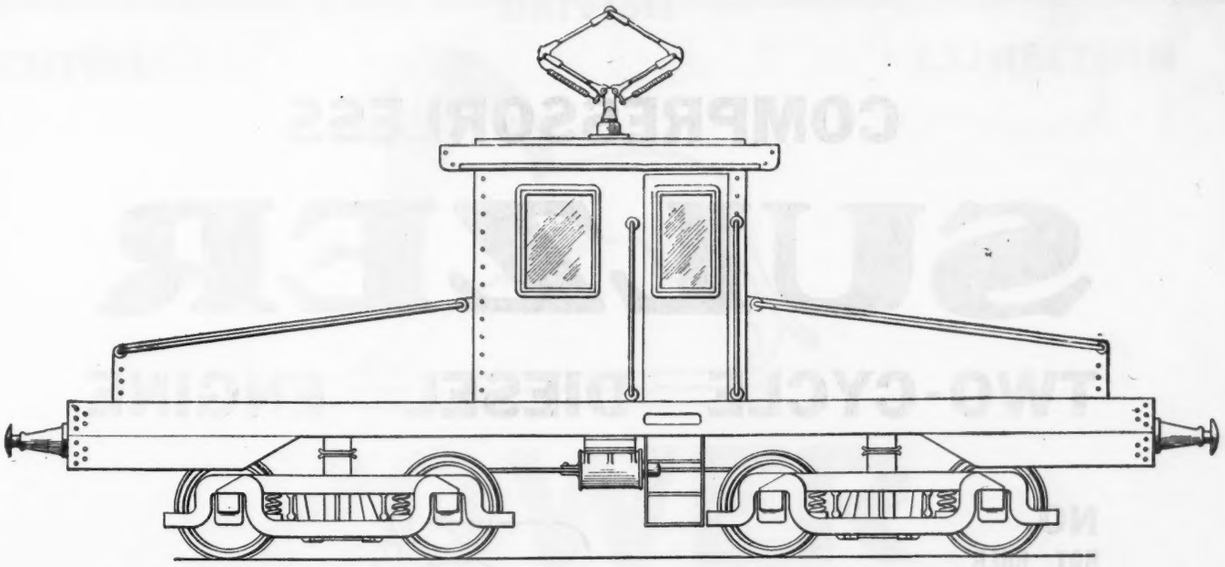

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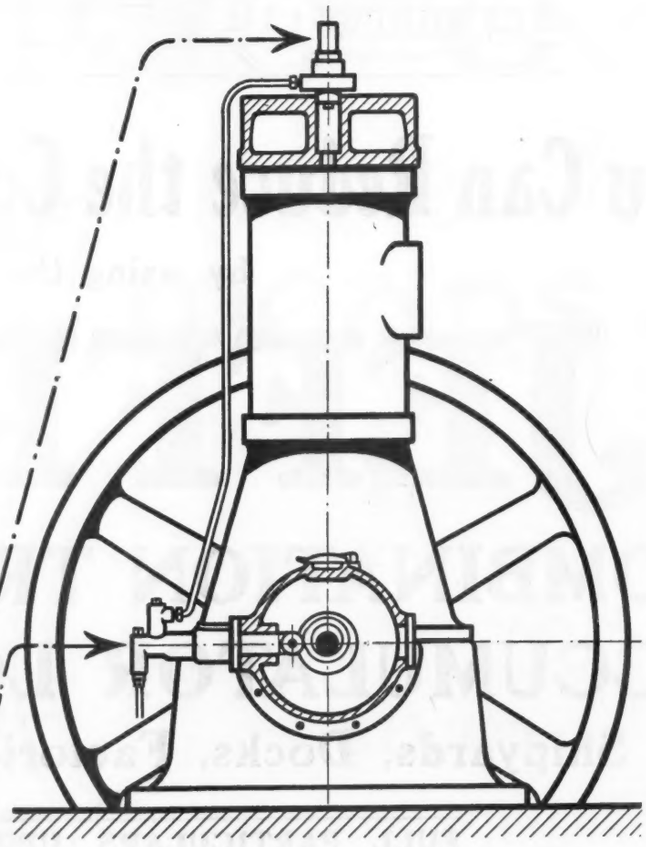

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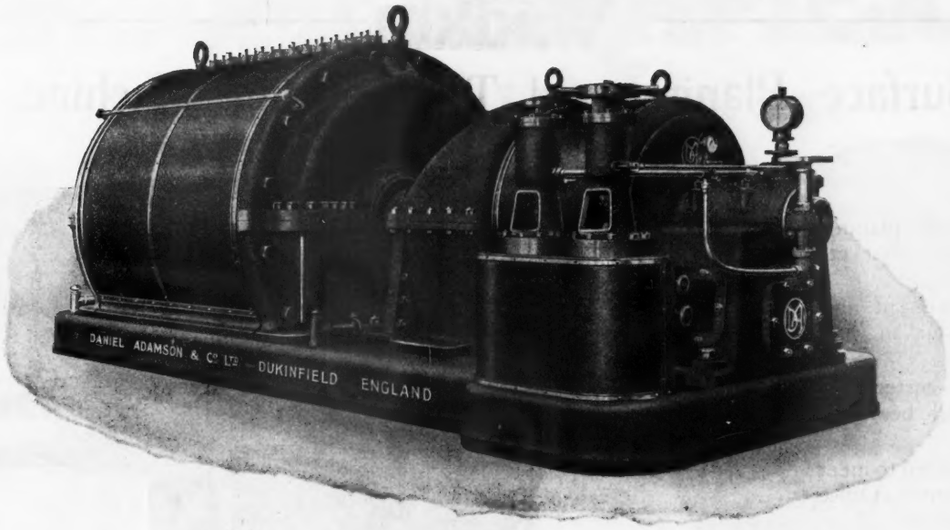

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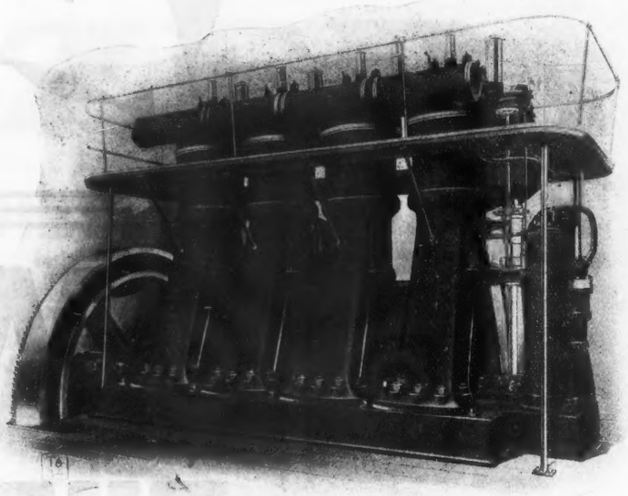

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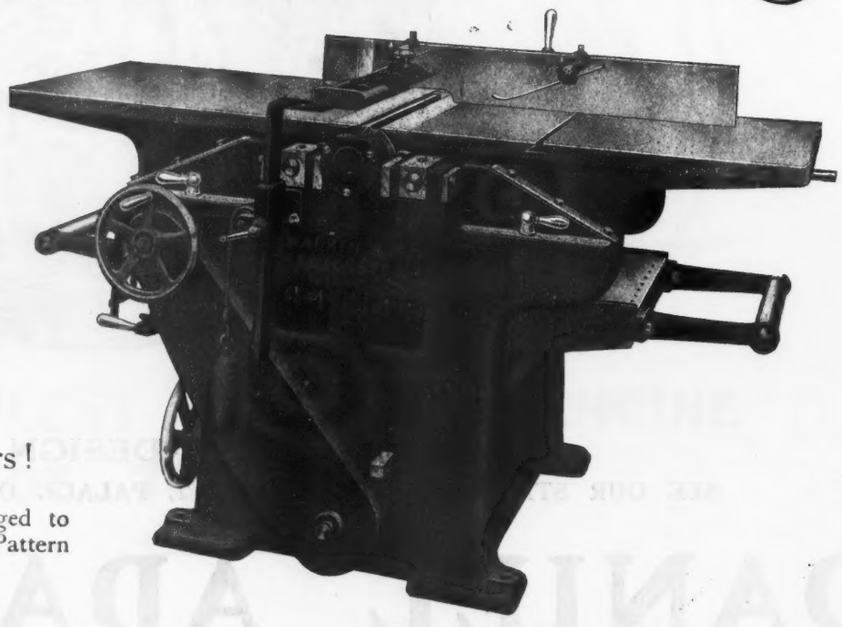

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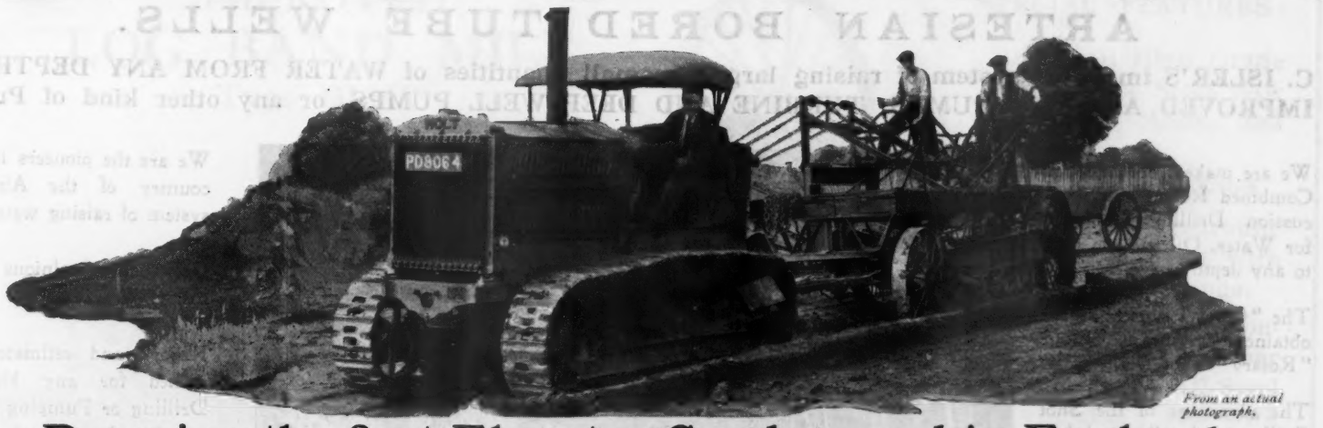

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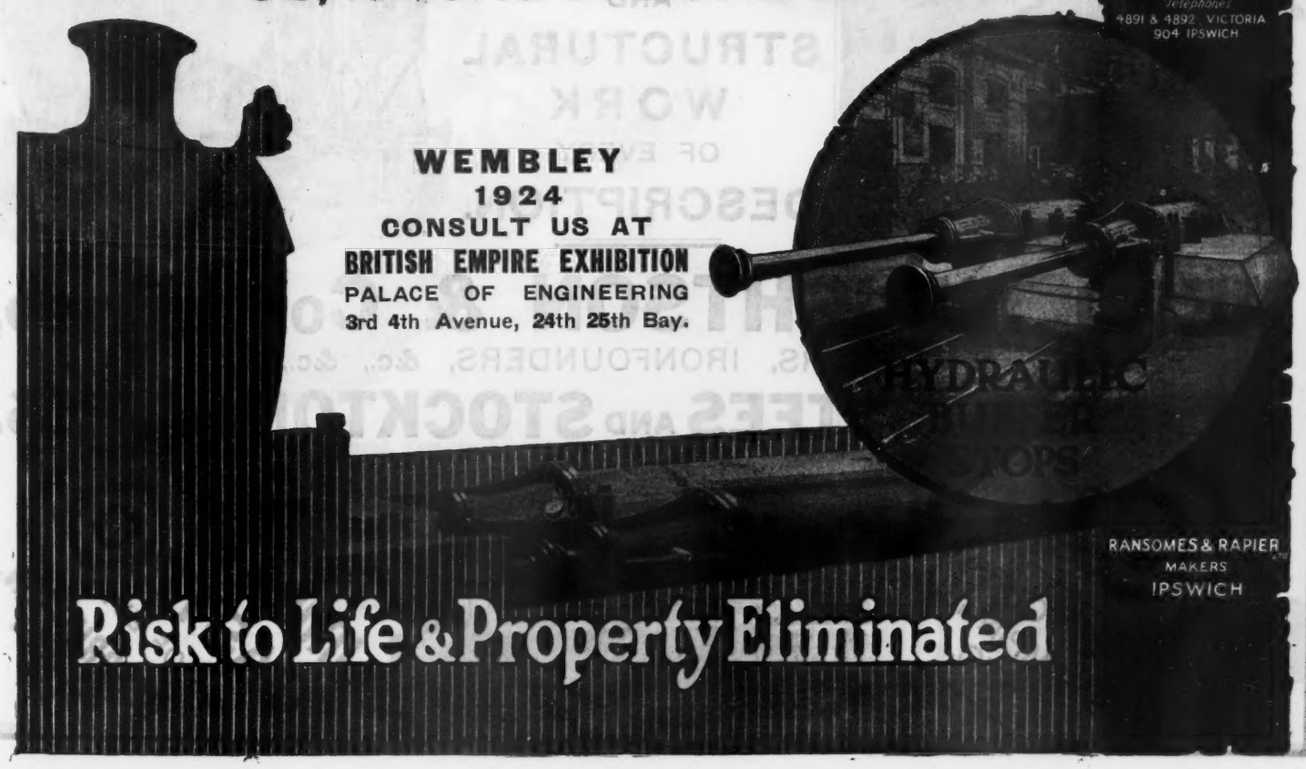

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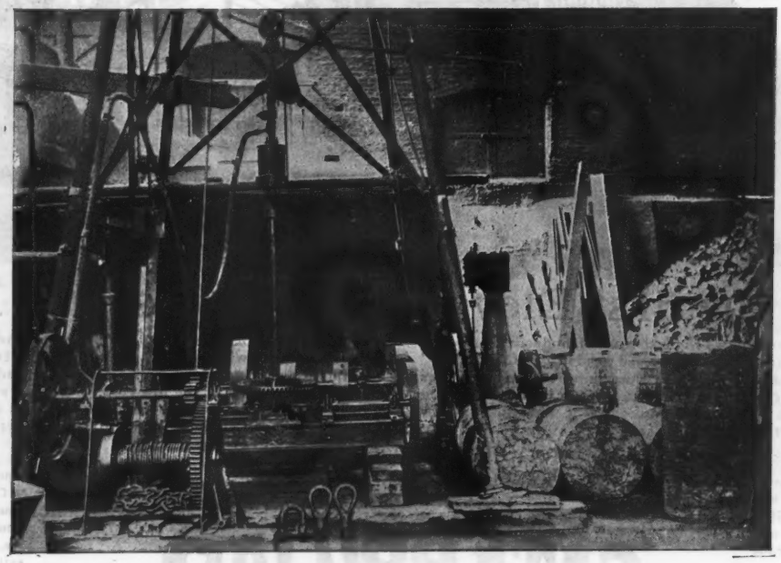

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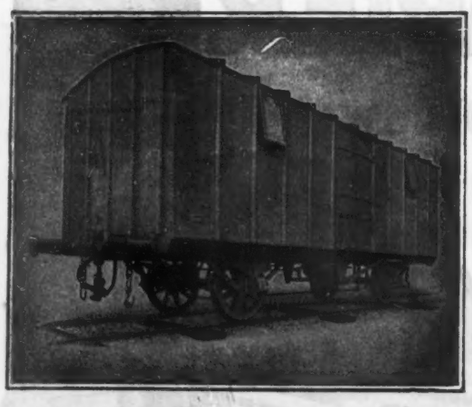

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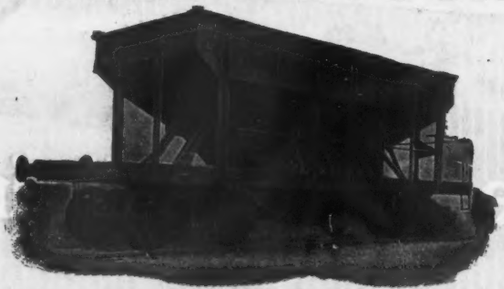

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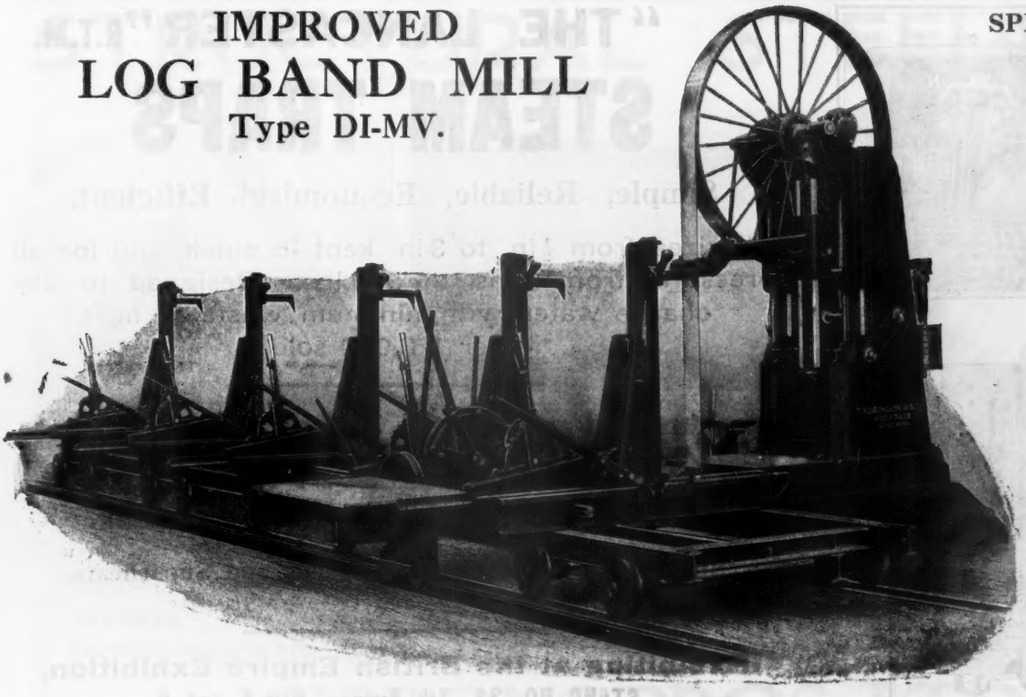

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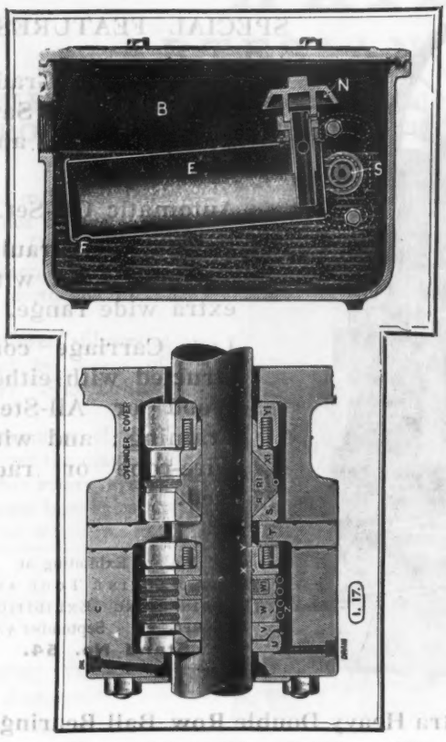

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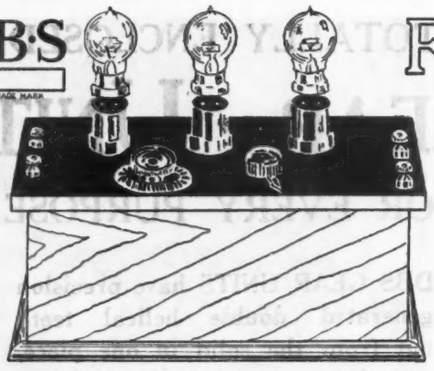

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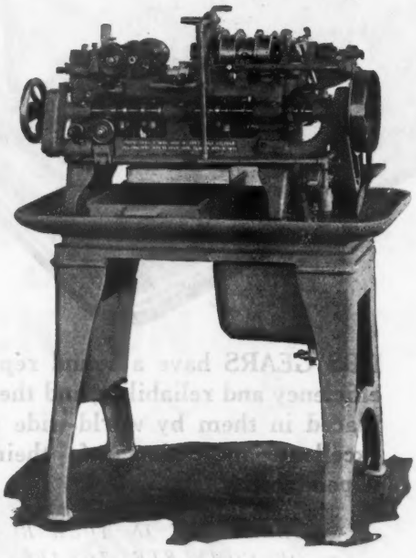

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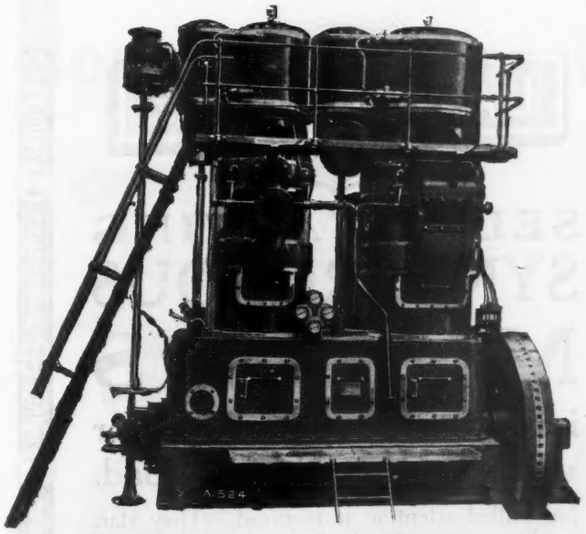

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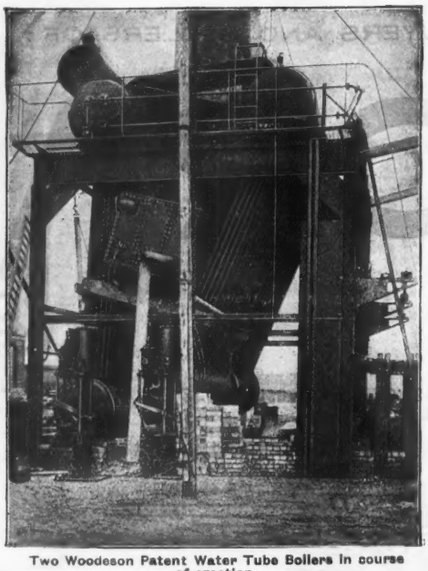

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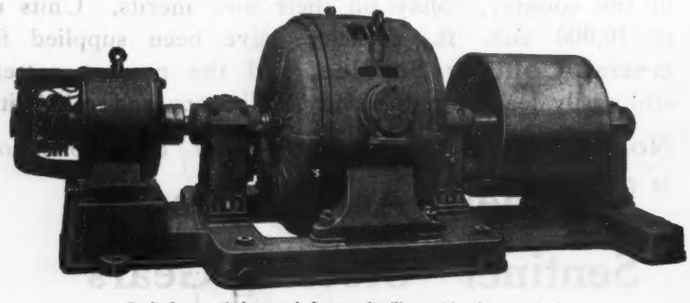

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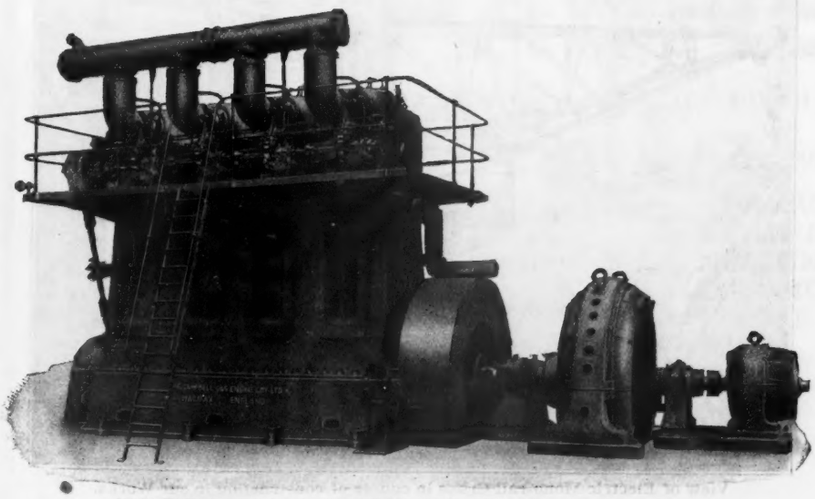

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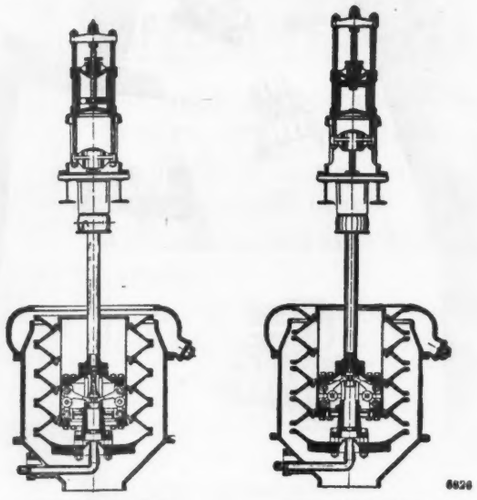

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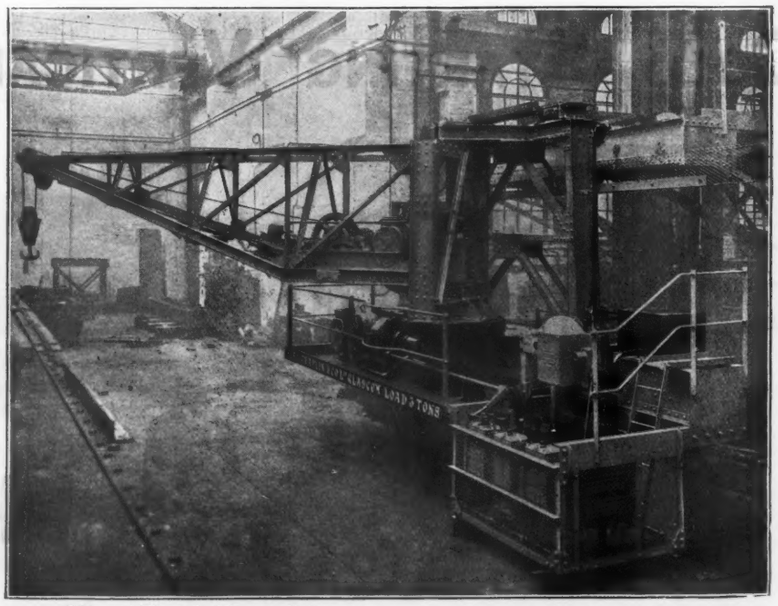

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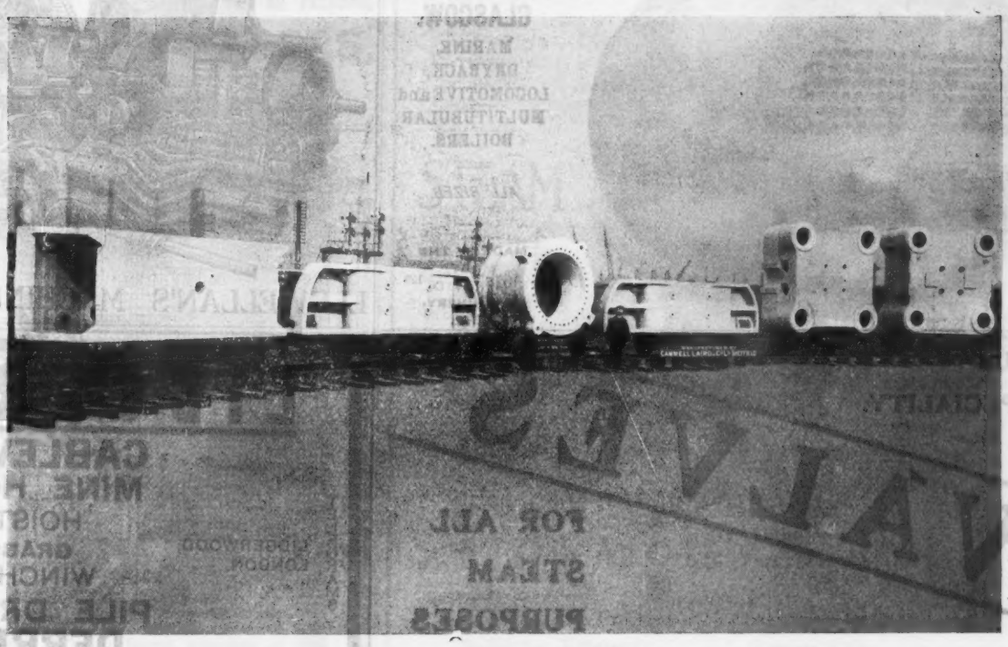

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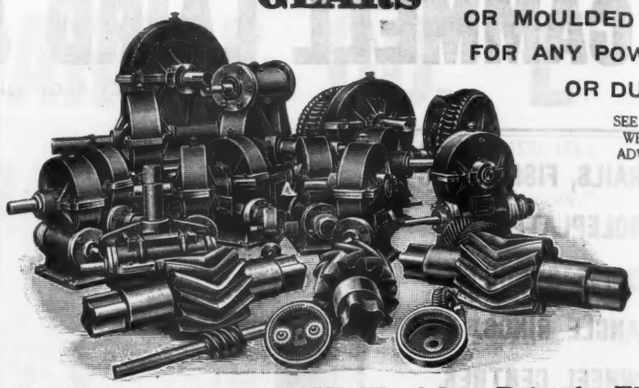

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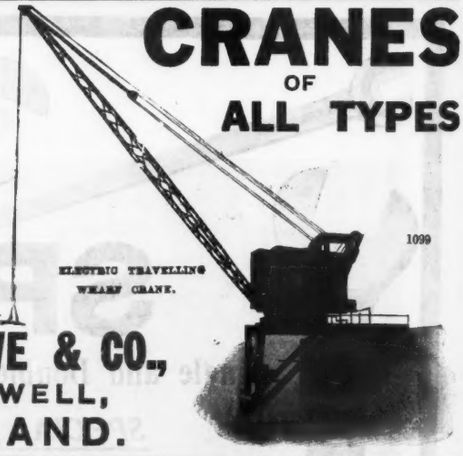

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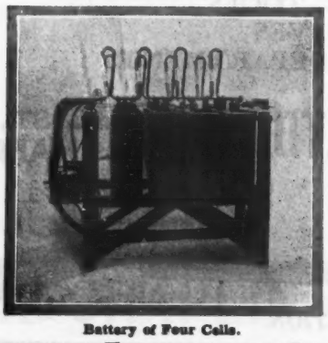

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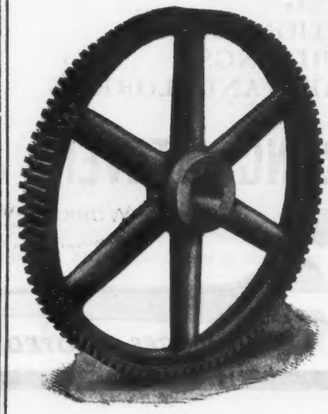

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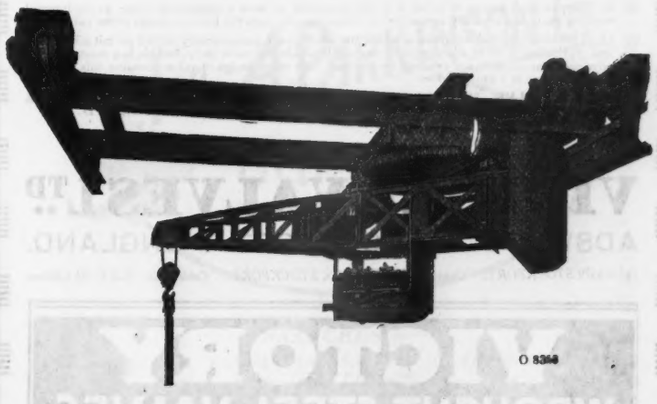

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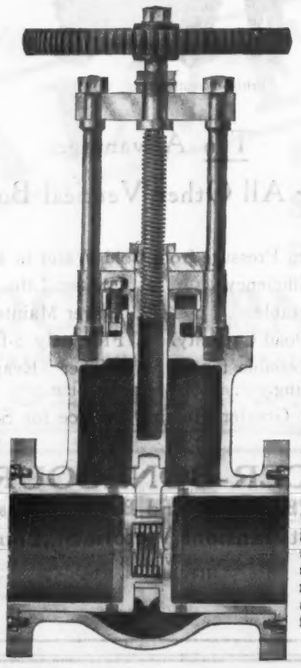

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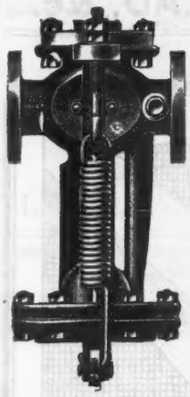

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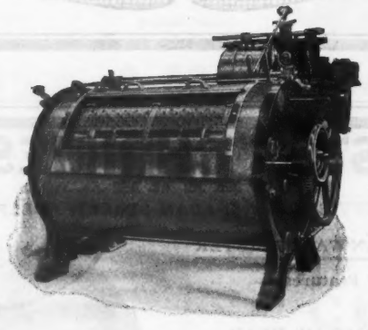

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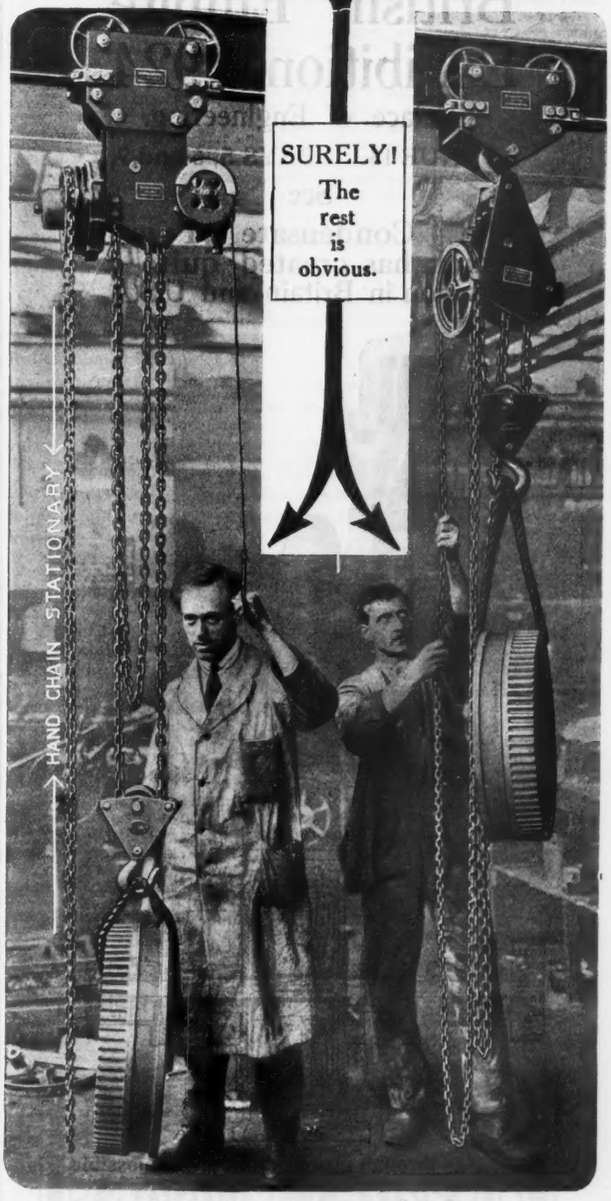

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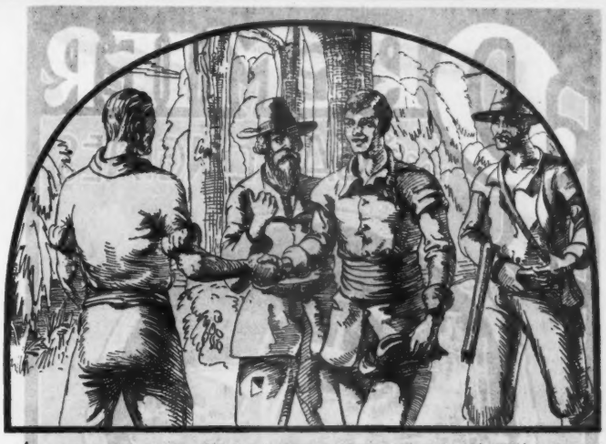

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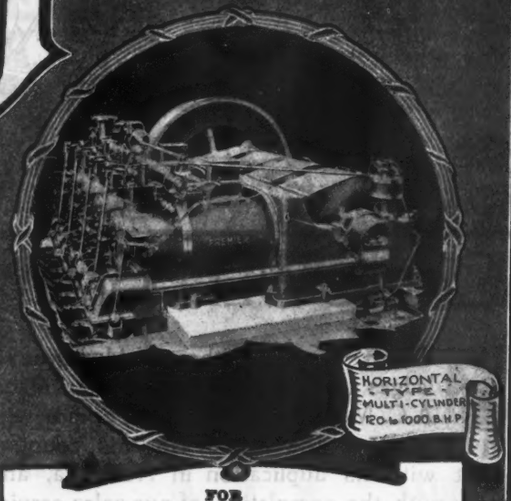

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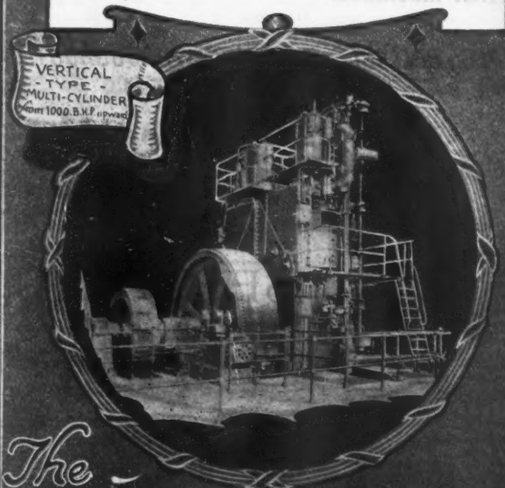

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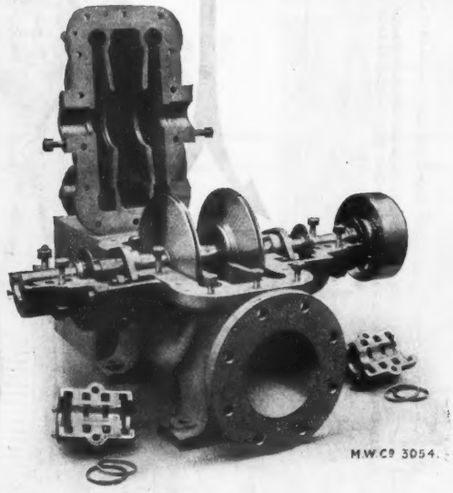

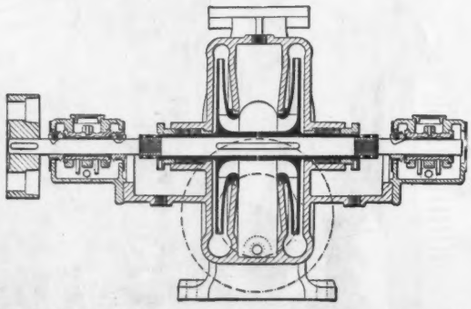

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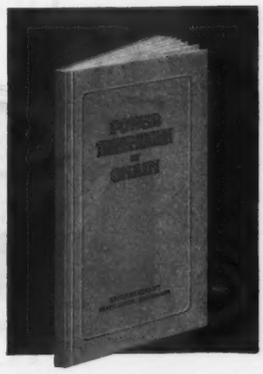

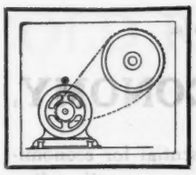

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Points for Consideration when Incorporating Chain Gearing -
Horse Power and Chain Speeds—Centrifugal and Catenary Loads—Safety Factors and Joint Pressure—Relative Position of Shafts—Adjustment of Centres—Adjustment on Vertical Drives—Direction of Rotation—Shaft Centre Distance—Size of Chain Wheels—End Play on Shafts—Irregular Loads—Chain Driven Feeds on Automatics.

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Gear Ration—Chain Speed—Centre Distance between Shafts—Normal Maximum Joint Pressure.

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Chain Gearing for Auxiliary Drives on Internal Combustion Engines and Automobiles - - - - - - - - -
Disadvantages of Toothed Gearing—Advantages of Chain Gearing—Adaptability of Chain Drive to Engine Design—Non-adjustable Drives—Adjustable Drives—Engagement of Chain on Wheels—Lubrication—Type of Chain.

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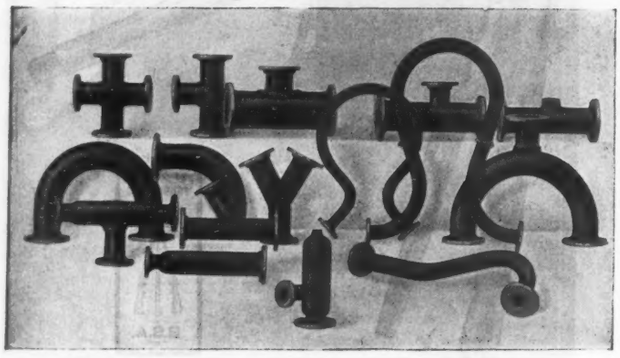

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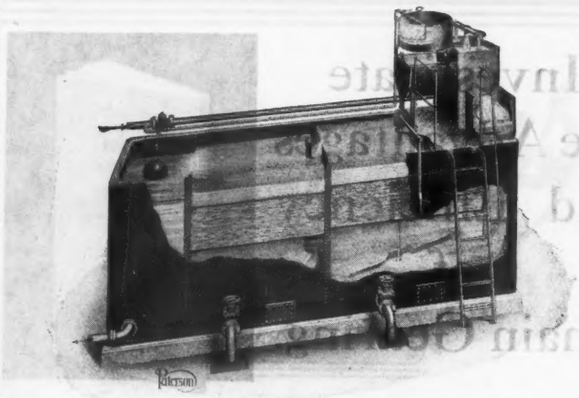

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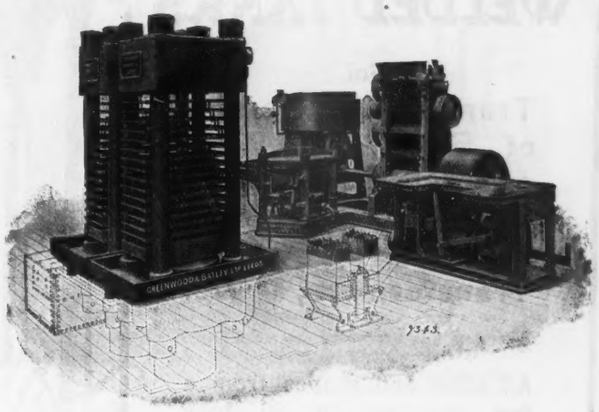

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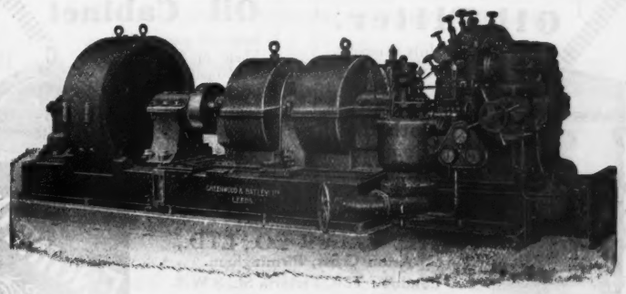

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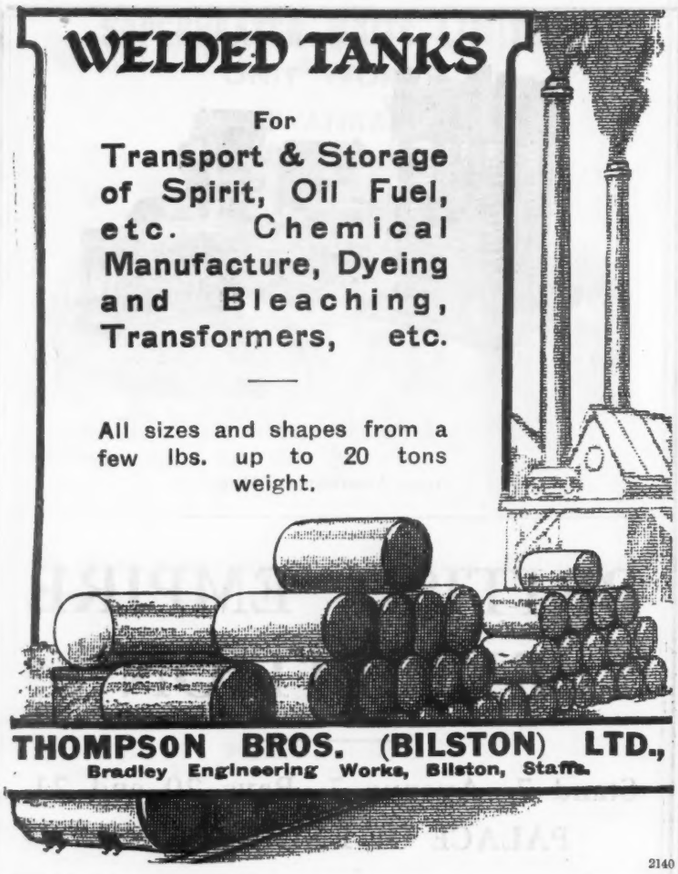

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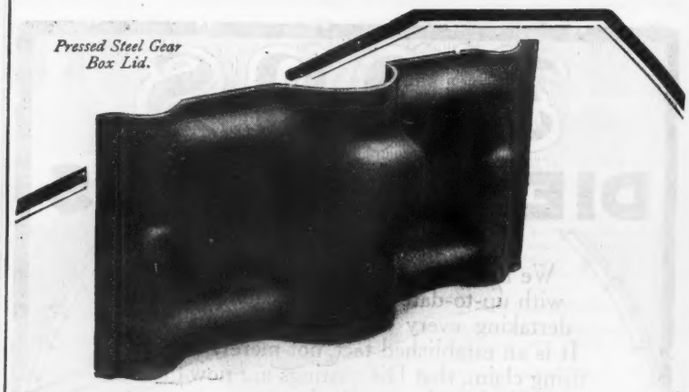

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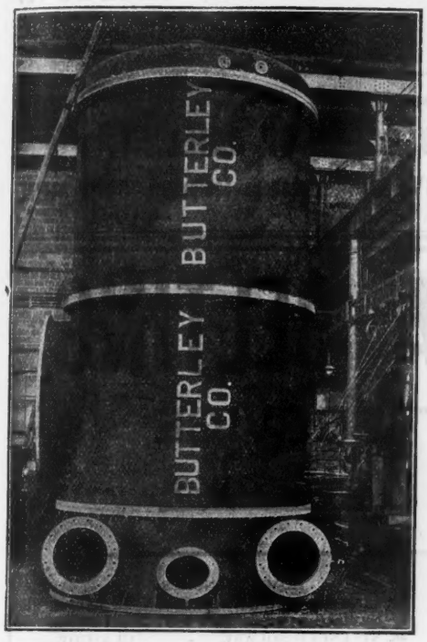

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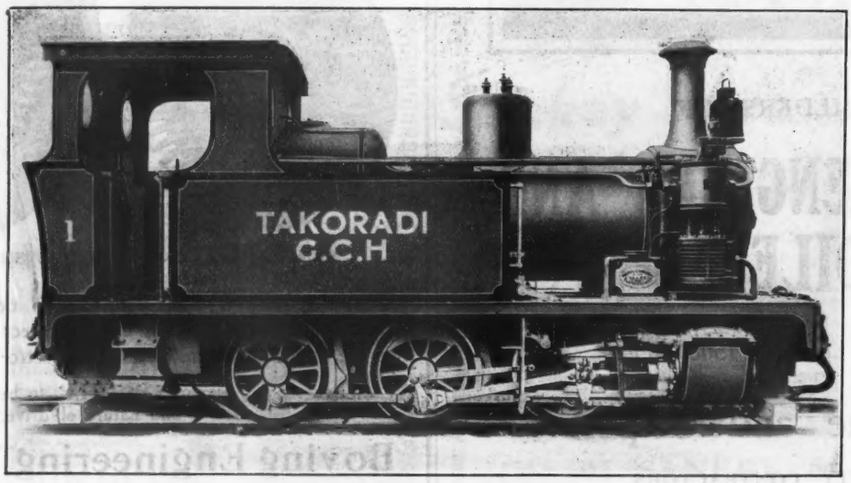

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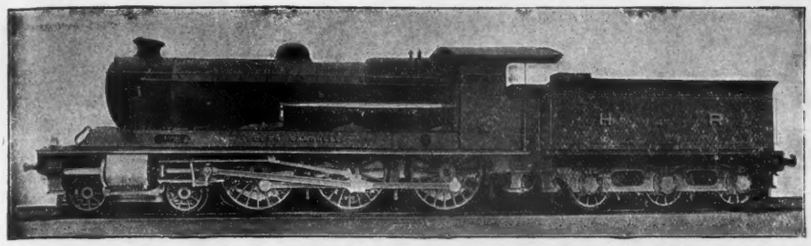

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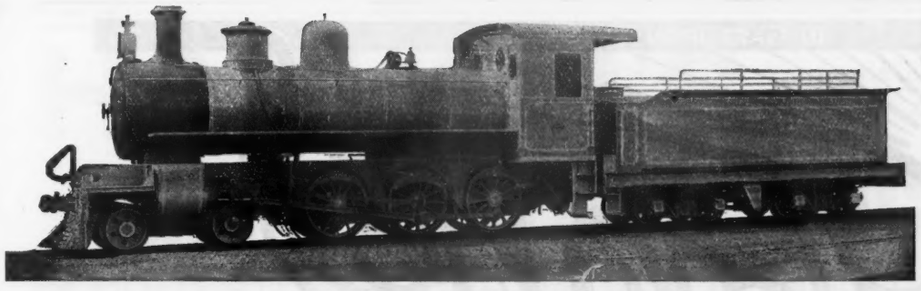

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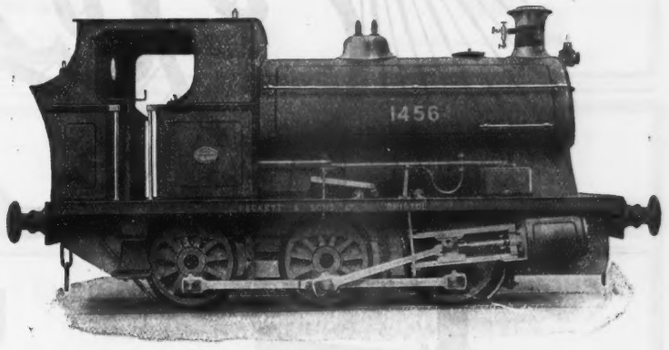

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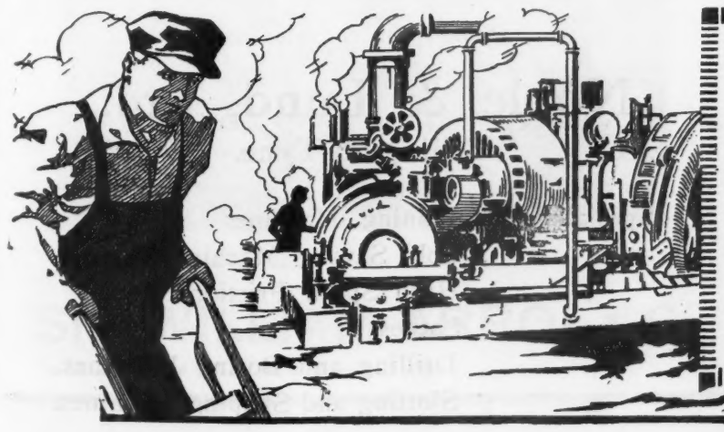

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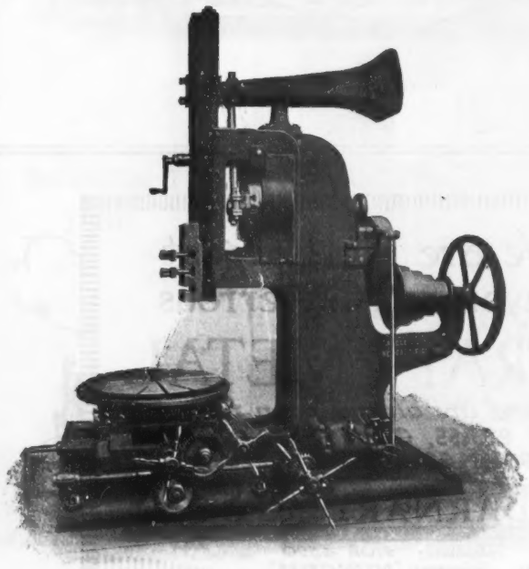

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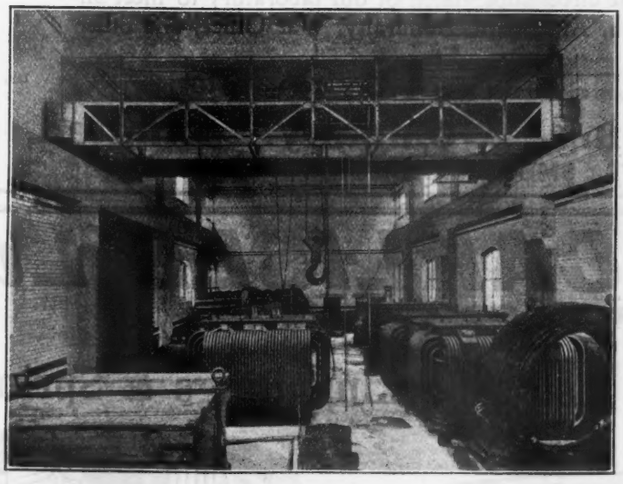

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LOCOMOTIVES & THE ENGINEERING & MOTOR TRADES.

Works: ASTON MANOR, BIRMINGHAM. 3651

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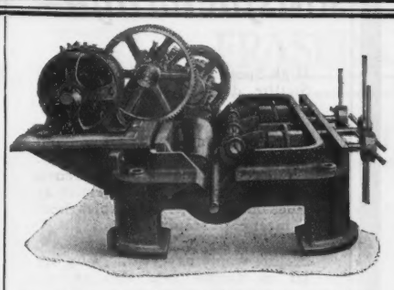
3651

MACLAURIN PATENT
CARBONIZING PROCESS
Sole Licensees and Manufacturers
BLAIR, CAMPBELL & McLEAN, LTD.
GLASGOW. 2094

THOS. SUDRON & Co., Ltd.,
STOCKTON-ON-TEES.
MAKERS OF MARINE AND VERTICAL TYPE BOILERS. SHIPS MASTS. TANKS. MOORING BUOYS, STEEL LADLES, TUBING, Etc. 2123



No. 2 ABRAMSEN STRAIGHTENING MACHINE. (Patent No. 9293/14).

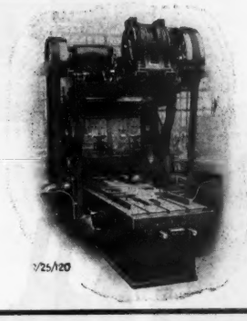
J. BIGWOOD & SON, LTD.,
Engineers (ESTABLISHED 1874), Wolverhampton.

This machine
WILL COLD STRAIGHTEN
at from 40 ft. to 60 ft. per minute
ANY STEEL BARS
up to 85 TONS TENSILE. 1744

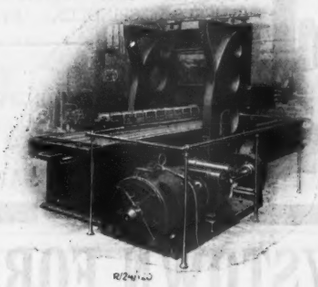
NEWTON BROTHERS, (DERBY) LTD., PLANER DRIVE

ENGINEERS, DERBY.

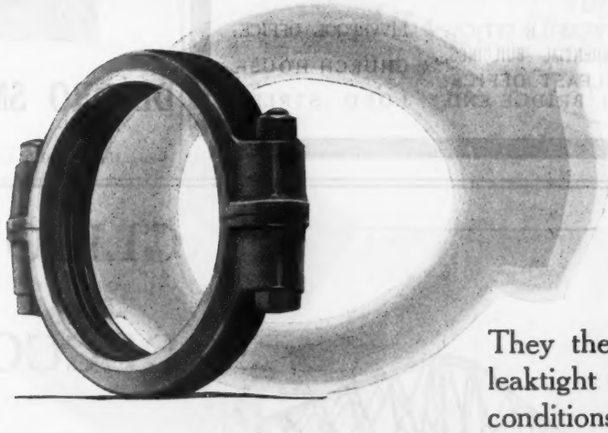
MODERN HIGH-SPEED PLANER ORIGINAL DRIVE.



MODERN HIGH-SPEED PLANER WITH NEWTON-DERBY DRIVE.



OWNER REPORTS
POWER INPUT DECREASED 52%
WORK OUTPUT INCREASED 105%



COST

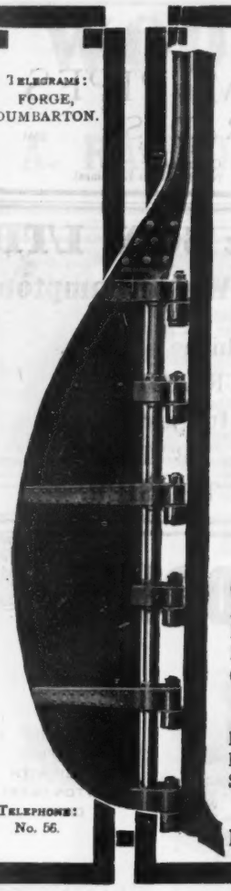
Victaulic pipe-lines cost the same as ordinary loose-flange tubing, in sizes over 6″; below that, 2½% to 5% more. Because they are flexible under pressure, they are unaffected by vibration, or expansion and contraction of the pipes and movement of the ground.

They therefore remain leaktight under severe conditions, saving the cost of maintenance and the money usually lost by leakage.

Specify Victaulic Joints when ordering tubing through your usual suppliers.

The VICTAULIC COMPANY LTD.,
28, VICTORIA STREET, WESTMINSTER, S.W. 1.

VICTAULIC



TELEGRAMS: FORGE, DUMBARTON.

TELEPHONE: No. 56.

EXCEPTIONALLY QUICK DELIVERY GIVEN FOR

FINISHED CRANK SHAFTS, PROPELLER SHAFTS with Continuous Gun-Metal Liners complete, and STERN AND RUDDER FRAMES.

STEEL AND IRON FORGINGS

UP TO ANY WEIGHT.

SPECIALITIES:—REPAIR WORK OF ALL DESCRIPTIONS, ALSO FINISHED HOLLOW CRANK AND LINE SHAFTING FORGINGS FOR TURBINE ENGINES (WHEELS, SPINDLES, DRUMS, &c.).

PATENTEES OF THE "WEDGWOOD" PATENT VERTICAL INTER-LOCKING SCARPHED JOINTED RUDDERS.

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DENNYSTOWN FORGE CO.

DUMBARTON.

2147

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NEWCASTLE OFFICE: PRUDENTIAL BUILDINGS.

BELFAST OFFICE: 101, BRIDGE END.

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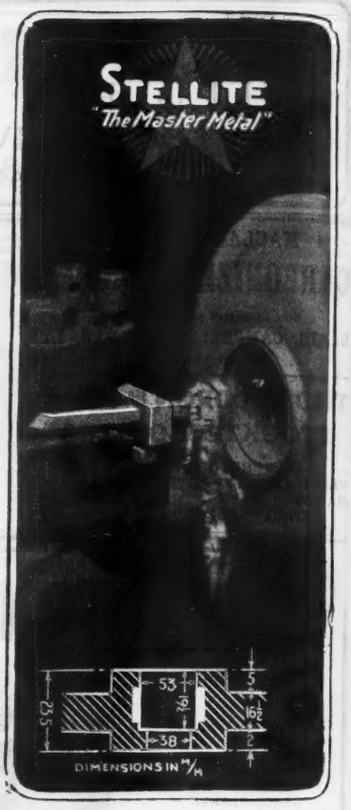
Nothing else would do this job satisfactorily—

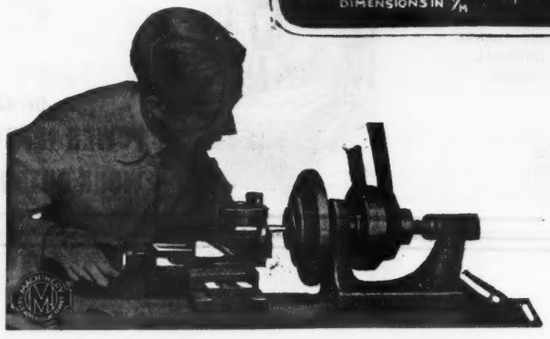
High Speed Steel failed on this job. Stellite does it easily. ***Stellite Pays!***

The machine is boring and facing magneto distributor boards: ebonite with four g.m. segments, and accuracy is as important as quick output. Stellite enables them to meet both requirements.

Stellite would pay ***you***. Why not let us demonstrate this at our own expense.

Write us.

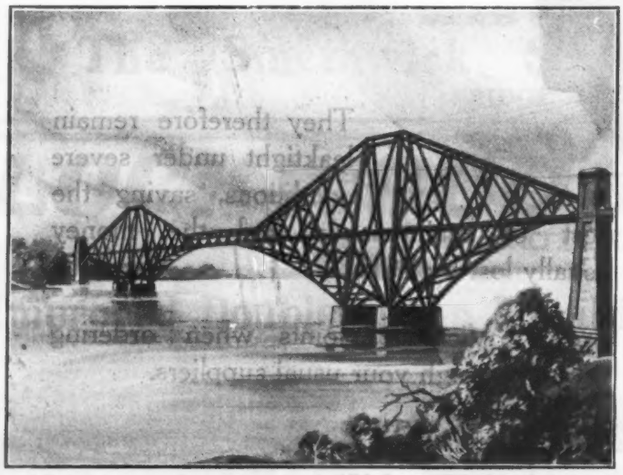




1684

DELORO SMELTING & REFINING CO., Ltd.

Norwich Union Chambers, Congreve Street, BIRMINGHAM. Britannic Works, Fleet Street, BIRMINGHAM.



To preserve Steel and Iron Work mix your paint with either Glico White Spirit or Decco Turps.

GLICO WHITE SPIRIT

The Best Turpentine Substitute.

DECCO TURPS

Gives that Durable Finish.

Supplied in various sized packages to suit Buyers' requirements.

Prompt Deliveries in all Manufacturing Districts from Local Depots.

GLICO PETROLEUM, LIMITED,

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THE GAS LIGHTING IMPROVEMENT CO., LTD.,

Alexandra House, Queen Square, W.C. 1.

Telegrams: Carburine Holb London. Telephone Nos.: Museum 7400, 7401, 7402, 7403, 7404.

2134

ECONOMICAL HANDLING OF MATERIALS

Visit THE G.E.C. PAVILION,
Palace of Engineering,
BRITISH EMPIRE EXHIBITION.

(ROBINS SYSTEM)

The illustration shows a 24 in. wide Robins Belt Conveyor, inclined 20 degrees, carrying 250 tons of stone per hour. It was installed to serve a contractor who was constructing the great ferro-concrete bridge over Hell-gate at New York City. This conveyor carried all the contractor's materials, stone, sand, bags of cement and coal.

Large numbers of successful plants have been supplied and erected, both at home and abroad, for handling coal, ore and other materials. Enquiries invited.

FRASER & CHALMERS ENGINEERING WORKS

PROPRIETORS: THE GENERAL ELECTRIC CO. LTD.

ERITH, KENT

LONDON OFFICE:
Magnet House, Kingsway, W.C. 2.

ASSOCIATED WITH ROBINS CONVEYING BELT CO. OF U.S.A.

The experience of Fraser & Chalmers Engineering Works combined with Robins Conveying Belt Co. of U.S.A., is placed at the disposal of intending purchasers of plant for the ECONOMIC HANDLING OF MATERIALS.

2022

GROUND FLOOR SPACE ALL BOOKED
GALLERY SPACE ONLY AVAILABLE

at

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OLYMPIA, LONDON.
5th—27th September, 1924.

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J. Wigglesworth & Co Ltd
SHIPLEY ~ YORKS

COUPLINGS
1499

BRAIME'S LATEST IMPROVED ALL STEEL SHOP TOOL STANDS
Are Unbreakable.

Also these Pans are Most suitable for Engineers, Bolt, Rivet and Screw Works Brass Founders, &c.

Seamless Steel Shop Boxes and Trays
Large Assortment of Patterns.

Plain Stand.

Fitted with Steel Locker with 2 Keys each.

SPECIALITY. 1264
ENGINEERING STAMPINGS to over 30" dia.
The above Goods to be had from all Engineer Factors and Merchants.
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SOLE MAKERS. **T. F. & J. H. BRAIME, Ltd., Hunslet, Leeds.**

The Strongest Chain in the World.
WELDLESS STEEL CHAIN
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FOR .. Cranes, Slings, | Cage Bridles, Coupling Chains, | Steering Gears, Mooring, | Hauling, Mining,
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'Phone—Coatbridge 112. Gartsherrie, Coatbridge. 'Grams—"Weldless, Coatbridge."

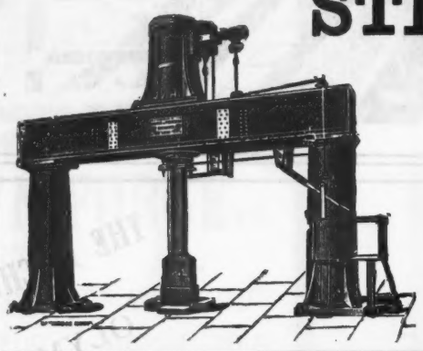
GLENIFFER MARINE MOTORS
See Illustrated Advt. page 21, June 6.
GLENIFFER MOTORS, LTD.,
Anniesland, GLASGOW. 2096

Ritchie-Atlas CONVEYING MACHINERY 1544
RITCHIE-ATLAS ENGINEERING CO: ATLAS WORKS • TEMPLE • GLASGOW.

MELDRUMS LTD. FOR OIL BURNERS
In case of a Coal Strike, for ordinary duty; combined oil and solid fuel, or Stand-by.
Ask for List 106 F. 1909
TIMPERLEY, MANCHESTER.

STEEL CASTINGS
STEEL AND IRON FORGINGS.
THE DARLINGTON FORGE LTD.,
DARLINGTON.
Tele.: "FORGE, DARLINGTON." Tel. 2010
(*See advertisement, page 74, June 20.*) 2167

Liverpool Refrigeration Co. Ltd.
Liverpool, England.
See last and next week's number. 1918

STEAM HAMMERS


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Shipbuilders' and Boiler Makers' Machine Tools.
PATENT BEVELLING MACHINES
FOR SHIPS' FRAMES.
FORGECRANES, Hand & Steam.
Sugar Cane Mills. Water Wheels, &c.
DAVIS & PRIMROSE,
Limited, 1913
BANGOR WORKS, LEITH, EDINBURGH.

2185
IRON ROOFS & BUILDINGS
CONSTRUCTIONAL IRONWORK
TANK MAKERS & GENERAL IRON & STEEL PLATE WORKERS
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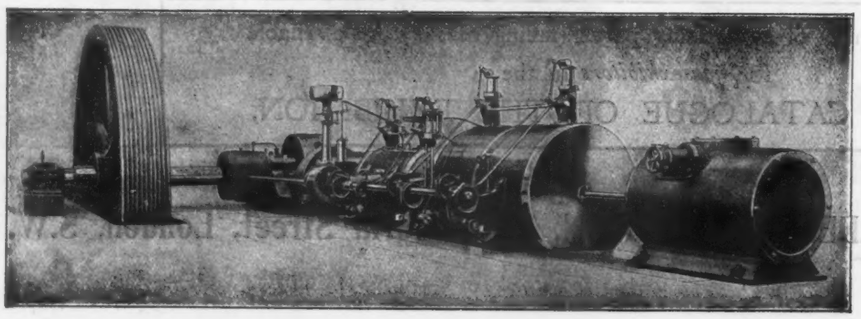
REA STREET SOUTH
BIRMINGHAM
GALVANIZERS
OXY-ACETYLENE WELDING



800 HORSE POWER TANDEM DROP-VALVE ENGINE.

NEWTON, BEAN & MITCHELL,
Engine Builders and Millwrights,
DUDLEY HILL, BRADFORD.
Telegrams: "ADROIT, DUDLEY HILL."
'Phone: 125, DUDLEY HILL (2 lines).
STANDARDISED MANUFACTURES.
UNIFLOW, TANDEM, CROSS COMPOUND and VERTICAL ENGINES.
All with our Improved Piston Drop Valves.
CONDENSING PLANT.
TRANSMISSION MACHINERY Of all kinds.
ENGINES INDICATED AND DETAILED.
REPORTS PREPARED.
We invite enquiries and correspondence, which shall have our best attention at all times. 862
LONDON AGENTS: Raymond Gill & Company, 92, Victoria Street, London, S.W.1.
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MILD STEEL PIPING FOR:

Exhaust Steam & Circulating Water.
Pipe Lines for Water Power, Sewage,
Suction and Discharge,
Gas and Tar Mains,
Air Blast,
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Tanks,
Air Receivers,
Condenser Shells,
Expansion Joints, Oil
Boilers, Jacketted Pans,
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Mild Steel Chimneys. . . .

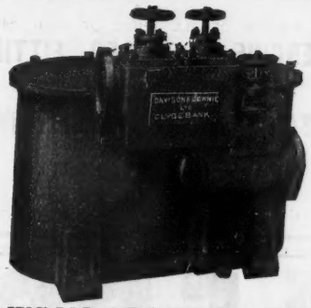
SPECIAL PIPES FOR ELECTRIC STATIONS.

Angle Flanges and Stamped Steel Flanges. 2216

TELEGRAMS: "AQUILENTUS, KIRKCALDY."

LONDON AGENTS: John Wilson (London), Ltd., 39, Lime Street, E.C. 3.

MARINE FEED WATER FILTERS.



DAWSON GRAVITY FEED WATER FILTER.

Correct in design and action. Moderate in price.

THE DAWSON (PATENT) GRAVITY FILTER.

Embodies all the essential requirements of a good Marine Feed Water Filter.

(1) The Gravity system allows the oil to be separated from the water without any tendency to force oil through with the water.

(2) The large surface and area of the filtering elements means a corresponding low speed of flow. This allows the oil or grease to be entirely separated from the water.

(3) The volume of filtering material gives from 4 to 6 times the filtering volume of any cloth covered filter without any increased resistance to flow of water.

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Telegraphic Address: "ABBOTT, NEWARK." (NEWARK, LIMITED), Telephone No. 34 ABC Code, 4th & 5th Editions

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CUSTOMERS' OWN PLATES WORKED AND FLANGED UNDER ADMIRALTY, BOARD OF TRADE, LLOYD'S, OR OTHER SURVEY, IF REQUIRED.

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MOTOR VAN BOILERS.
HYDRO CASINGS.
REPAIR FIRE BOXES.
EVAPORATOR SHELLS.
AIR RECEIVERS.
VULCANISING PANS, &c., &c.

1243

FROM PHOTO.

Wrights STEEL WIRE ROPES

For every Engineering Purpose
See illustrated advertisement page 36, June 6.

J. G. KINCAID & CO. LTD.,

GREENOCK,
Engineers and Boilermakers.

1547

See last and next week's illustrated half-page advt.

The MACFARLANE ENGINEERING CO., LTD.

Netherlee Road, Cathcart.
DYNAMOS and MOTORS
1866

B. THORNTON & SONS, Ltd.

BRIGHOUSE, YORKS.
Tel. No. 144.
Makers of Improved Continuous Wire Drawing and Winding Machines. 2080
Engineers and Millwrights.

BRICK MAKING MACHINERY
Herbert Alexander & Co. Ltd
Charmouth St.
LEEDS.

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3, 5, & 7, Old Queen Street,
LONDON, S.W.
Telephone: Victoria 3369.
Telegrams: SOLUTION, LONDON.
A B C and A1 Codes used. 1889
For Large Advt. see page 60, June 20.

CRANES

Samuel Butler & Co., Ltd.,
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For illustrated advertisement see next week's issue. 2283

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STAFFORD
BUILDERS OF LOCOMOTIVES
Weighing from 3 to 50 tons, for any gauge of Highest-Class Workmanship and Materials.
MAKERS OF 1596
Tipping Trucks. Sugar Cane Wagons. Turntables, Switches, &c.
See Illustrated Advert. page 56, June 13.

THE DRUM PUMP

Used for
WATER · OILS · TREACLE · TAR & OTHER SEMI-FLUIDS
No Valves
DRUM ENGINEERING Co. LTD
BRADFORD — YORKS.

TRADE +GF+ MARK.

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GAS, STEAM & WATER, ⅛ in. to 6 in.

OVER 7,500 VARIETIES. SEND FOR CATALOGUE. 4227

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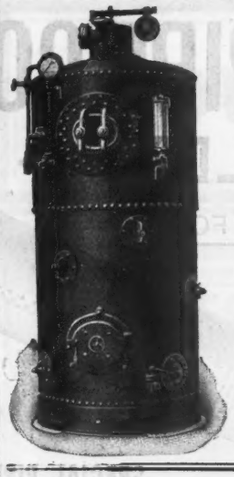
London Office: Dock House, Billiter Street, E.C. 3.



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VERTICAL STEAM BOILERS.
CORNISH STEAM BOILERS.
STORAGE CYLINDERS (Welded or Riveted).
AIR RECEIVERS. CALORIFIERS and FEED WATER HEATERS.
JACKETED PANS in Iron or Copper.
CORNISH TUBULAR BOILERS.
VERTICAL TUBULAR BOILERS.
UNDERFIRED TUBULAR BOILERS.

Boilers of all kinds for:—

CENTRAL HEATING & HOT WATER SUPPLY in Iron, Steel and Copper.

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FREMO WORKS, MOSELEY STREET, 1300

Delivery ex Stock. BIRMINGHAM. Any Size. Any Taper

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MAKERS OF ALL KINDS OF HIGH CLASS
ENGINE & BOILER FITTINGS

MAKERS OF
SANITARY & WATER FITTINGS.

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1628

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"WOODITE,"

The Best Material for GAUGE GLASS RINGS & STEAM PACKINGS

For Valves, Joint Rings, Pump Cups, Ram Rings, Packing Rings and Sheeting in all Sizes and Sections.

Contractors to H.M. Government, Admiralty, War Office, Post Office, India Office, and the Colonial and Foreign Governments.

The Best Material for all High Pressure Steam or Electrical Installations.

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WELDED **TANKS** RIVETED

FOR CHEMICAL WORKS, BLEACHING, DYEING, COKE OVEN PLANTS, ETC., AIR RECEIVERS, STEEL PIPES, STILLS, JACKETED PANS, STEEL CHIMNEYS.

1733

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Speciality

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BRIGHT DRAWN STEEL BARS. 3000

HARTNESS

Automatic Opening

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assure accurate pitch and lead—long threads or short; are completely interchangeable, positive opening, durably constructed and extremely economical.

Catalogue giving full particulars gladly sent on request. 2214

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To make sure your **RINGS are TRUE** *buy from*

The Standard Piston Ring & Engineering Co., LTD.

Premier Works, Don Road, SHEFFIELD.

Telephone No. 2149.
Telegrams: "Ocean," Sheffield.

The Original and Genuine Davey Robertson

HAMMERED CAST IRON PISTON RINGS

Our Hammered Piston Rings are well and favourably known all over the world for their efficiency and long wearing qualities. They keep the cylinders round and maintain a perfect joint until worn out. The pressure on the cylinder wall always remains constant.
All sizes, 2 in. to 72 in. diam. In our special quality piston ring iron, giving approximately 14 tons tensile per sq. inch.

Quickest Possible Delivery. 2107 Lowest Possible Prices.

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'Phone— SOUTHALL 2. **SOUTHALL, Middx.** Telegrams— SUBMERSE, SOUTHALL.

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PRICES GREATLY REDUCED.

Enclosed Ventilated Ball Bearing Dynamo.

SPECIALITY—
SUBMERSIBLE ELECTRIC MOTORS FOR PUMPING AND WET POSITIONS. 1597

THEY WORK IN WATER.

DOUBLE SECURITY

THE "BOSS" FULLWAY GATE VALVE

is fitted with bronze faced parallel discs, working against renewable bronze seats and operated by cams revolving in wedge shaped trunnions between the discs.

In closing the valve, the discs bearing the gunmetal move freely down until opposite the valve ports. The cams engage with lugs cast inside the body, bringing into action the wedge shaped trunnions which press the gates apart on to the seats, without injury to the faces and rendering the valve

DOUBLY SECURE AGAINST LEAKAGE 1590

The first movement of the spindle in opening the valve releases the trunnions and the gates move freely up with no tendency to stick or grind. The valve is made in all sizes from 2 up with screwed or flanged ends.

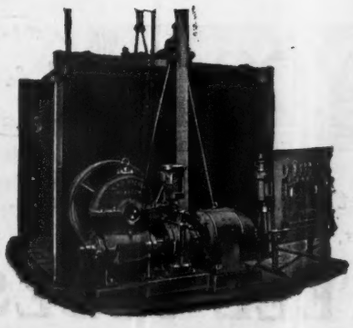
BRITISH STEAM SPECIALTIES LTD.

BEDFORD STREET, LEICESTER.

For all Types of Valves, Steam Traps and Fittings.

LIFTS. **A. & P. STEVEN, LTD.**

GLASGOW.



Stand 191.
British Empire Exhibition.
Avenue 1st. Bays 25-26.

London Office:
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BLACKFRIARS, S.E. 1.

Manchester Office:
12, CHARLES STREET.

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HARRY ASTBURY,
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PARADISE STREET. 2145

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GAUGE GLASS

A FULL RANGE OF OUR PRODUCTS WILL BE ON VIEW AT

STAND No. 140, Avenue 3, Bays 18 & 19,

BRITISH EMPIRE EXHIBITION, 1924.

(SHIPBUILDING, MARINE, MECHANICAL AND GENERAL ENGINEERING SECTION).

THE BELDAM PACKING & RUBBER CO., LTD.,

29, Gracechurch St., London, E.C. 3.

Telephone: Avenue 5204. ESTD. 1876. Telegrams: "VREPILOT."

Branches and Agencies throughout the World. 1746

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NEW & RE-CUT. ALSO SCREWING MACHINES TO **24** IN. 2044

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BRIGHT TURNED STEEL SHAFTING

800 TONS IN STOCK

1 in. to 8 ins. Diameter.
In Lengths up to 30 ft.

Write for New Illustrated Catalogue with Details and Prices.

HENRY CROWTHER & SONS LTD.

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WORKS: MANCHESTER AND DITTON (near Widnes).

COPPER SMELTERS COPPER AND BRASS MANUFACTURERS.
FLUID-COMPRESSED HYDRAULIC-FORGED
COPPER, BRASS AND BRONZE TUBES AND CYLINDERS
COPPER INGOTS. BARS. SHEETS & ELECTRO-COPPERING.

OFFICES: MANCHESTER. BRANCH OFFICES LONDON AND GLASGOW.

MANCHESTER.

1905

W. B. BROWN & CO. (BANKHALL), LD

CLOSE WORKS LIVERPOOL.

9275

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STEEL WIRE ROPES FOR ENGINEERING.

SEND FOR CATALOGUE.

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OF ALL DESCRIPTION
HYDRAULI
Rivetters, Flangers, Press
Cranes, Railway Carriage
Wheel Machinery, &c.
MUSGRAVE BROS
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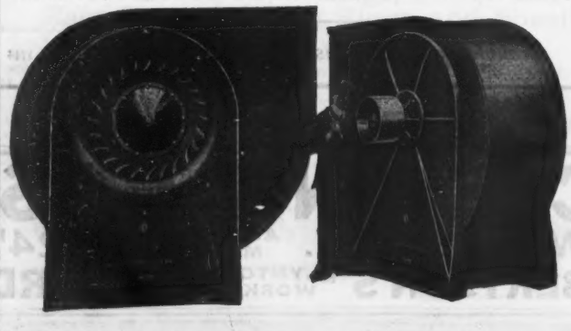

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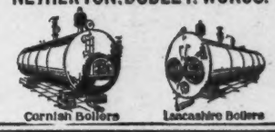

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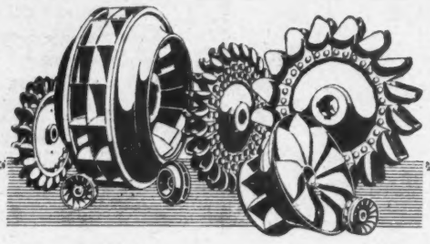

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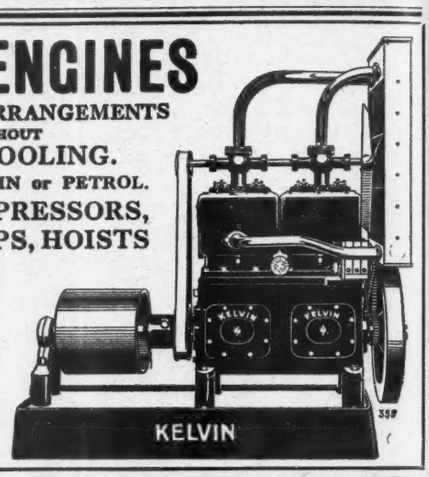

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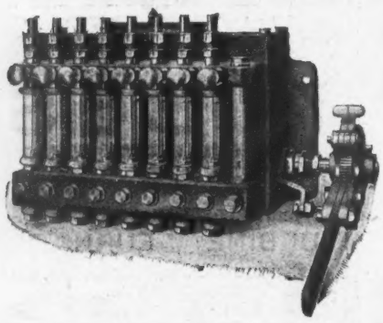

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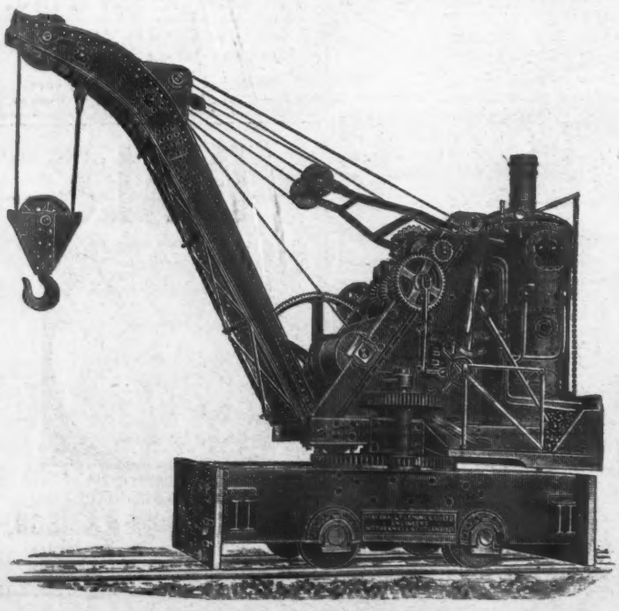

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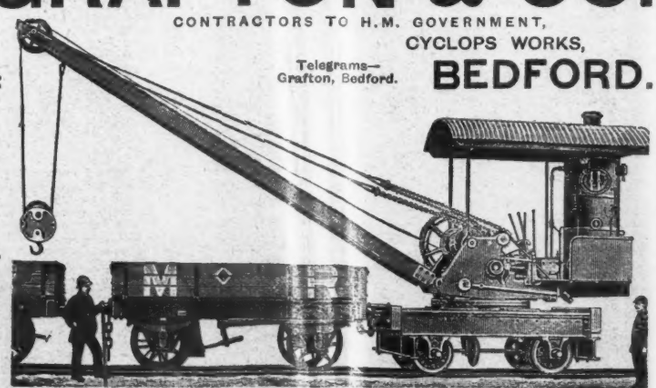

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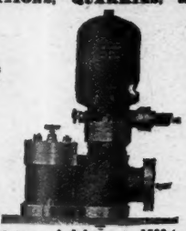

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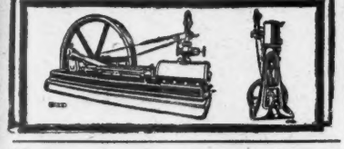

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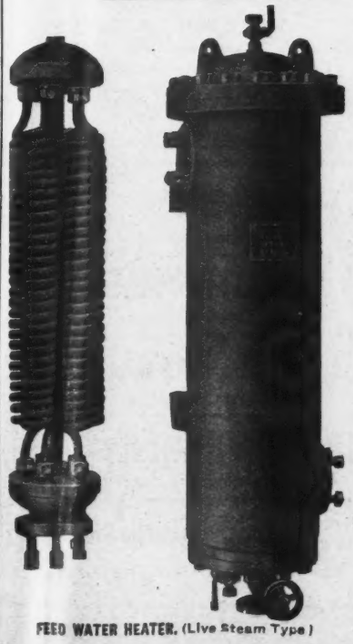

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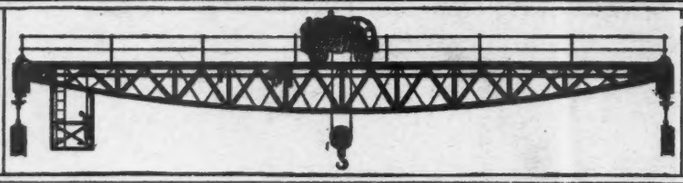

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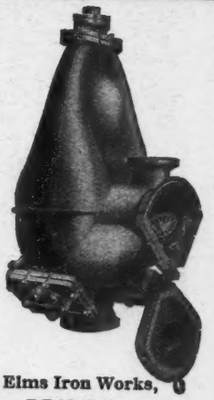

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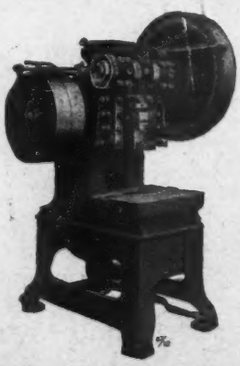

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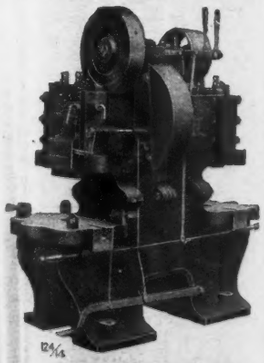

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